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The SCIENCE COUNSELOR

Volume XIII ★ Number 3 ★ Sept., 1950

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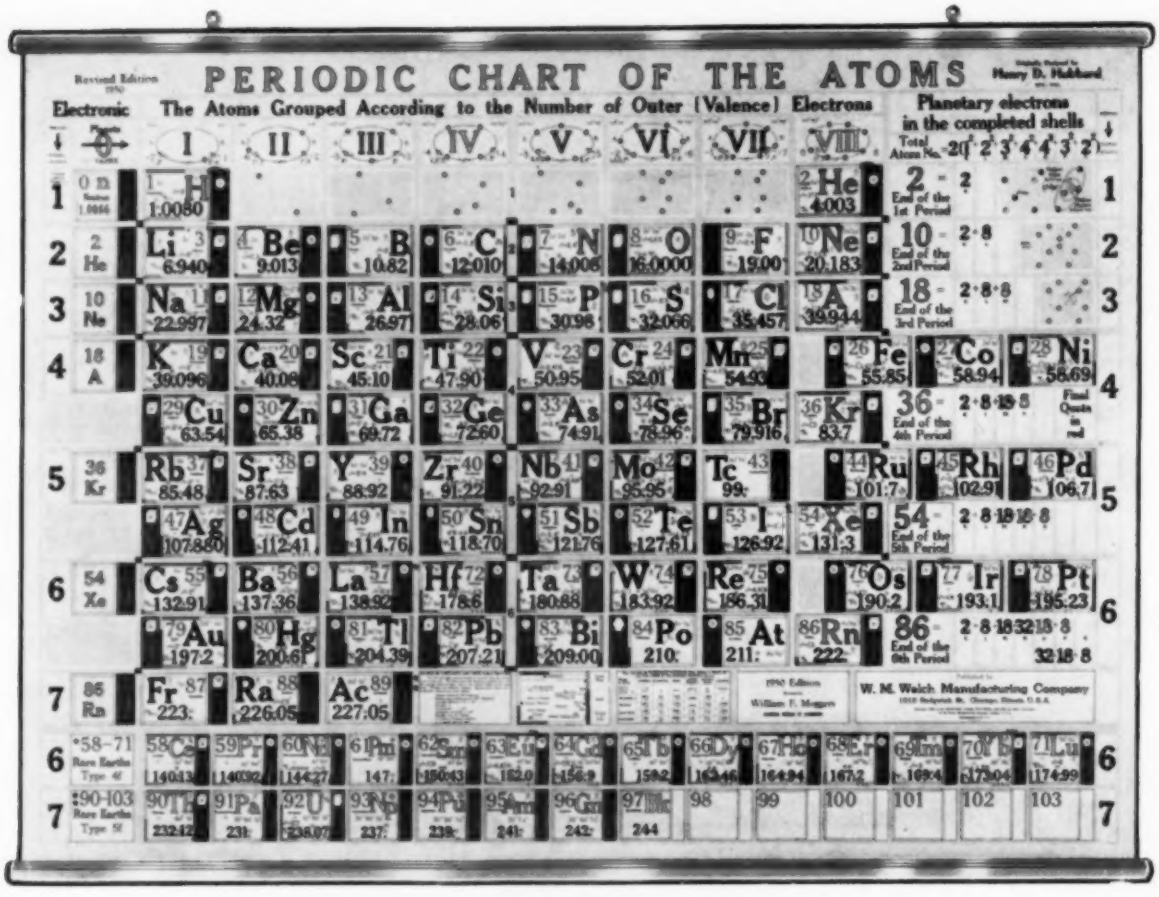

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Volume XIII September, 1950 No. 3

CONTENTS

IN FUTURE NUMBERS 81
STANDARDIZATION OF BASIC SCIENTIFIC ILLUSTRATIVE MATERIAL 82
William Brown McNett
VITAMINS BY THE TON 83
Paul J. Cardinal
COLLECTING PLANTS IN KODACHROME 85
Brother H. Charles
BUILDING A BETATRON ON A BUDGET 86
Francis J. Jankowski
THE NUTRITIONAL APPROACH TO THE PREVENTION OF DISEASE 88
J. F. Wischhusen, N. O. Gunderson
BIG TREES AND A CAMERA 90
S. Glidden Baldwin
HOW DID LIFE ORIGINATE? 92
Lillian L. Imperi
SEVENTY-FIVE YEARS YOUNG—THE OLDEST AGRICULTURAL EXPERIMENT STATION IN AMERICA 93
C. L. W. Swanson
TIN IS A USEFUL METAL 95
Robert M. MacIntosh
NEW LIGHT ON BETTER SIGHT 98
R. I. Bull
INDUSTRY DISCOVERS LITHIUM 100
John D. Clark, Ralph G. Verdieck
FACTS ABOUT FURS 102
Donald C. Daugherty
DOES LIGHT WEAKEN WITH DISTANCE? 104
F. M. Steadman
NEW BOOKS 106

In Future Numbers . . .

Among the articles planned for publication in the near future are:

Cortisone

By Edward C. Kendall, Division of Biochemistry. Mayo Foundation, Rochester, Minnesota.

•

The Venomous Cone Shells

By Robert T. Abbott, Division of Mollusks, National Museum, Washington, D. C.

•

The Story of Vitamin B_{12}

By John Valiant, Organic and Biochemical Research Department, Merck & Co., Rahway, New Jersey.

•

Loran

By Fletcher G. Watson, Graduate School of Education, Harvard University, Cambridge, Massachusetts.

Control of Flowering by Photoperiod

By Marguerite Gilstrap, U. S. Department of Agriculture, Bureau of Plant Industry Station, Beltsville, Maryland.

•

The Present Status of Cancer Research

By Jesse P. Greenstein, Chief, Section on Biochemistry, National Cancer Institute, U. S. Public Health Service, Bethesda, Maryland.

•

Oil From the Earth

By Leonard Davis, Shell Oil Company, New York, New York.

•

Furfural

By Bayne Freeland, The Quaker Oats Company, Chicago, Illinois.

•

Ten Days in Goethe's Life

By George E. F. Brewer, Head, Department of Chemistry, Marygrove College, Detroit, Michigan.

Standardization of Basic Scientific Illustrative Material

● By William Brown McNett
ART EDITOR, THE BLAKISTON COMPANY, PHILADELPHIA, PENNSYLVANIA

The difficulty of providing properly prepared illustrations for science textbooks at reasonable cost perplexes both authors and publishers. A number of factors are involved. Authors lack time and the necessary skill. Only a few artists are specially trained to undertake the work. Much good material that is apparently available is inaccessible for various reasons.

Here is suggested a "somewhat Utopian" but entirely feasible plan for meeting the situation. It can be worked. It will be, if enough people become interested in it.

●

The present status of scientific illustration is deplorable. I say this in no spirit of carping criticism, rather in the hope that something may be done, and soon, to revive the spirit which in some of the scientific classics of the last century flowered into what are the finest examples of engraving and lithography in any literature.

True, wealthy patrons were responsible for much of this. The door to such sources is closed today. But there must be found means to assure today's and tomorrow's science writers of trained artists adequate to illustrate modern textbooks in a competent style.

The field of medical illustration was rather bleak in the latter decades of the last century. The arrival of Max Brödel in America in the early 90's began a renaissance which brought American medical illustration to the forefront of the world, and has assured medical writers of a pool of trained artists to call upon.

The economic factors behind medical writing differ from those in the field of science, and the costs of acquiring a completely fresh set of illustrations for each new science text would be prohibitive. Few scientific writers are able to retain an artist, full time, for themselves, unless it might be a talented student who can draw satisfactorily. But these student artists are soon lost to the writer by graduation, and the time spent in their training is lost to both teacher and pupil. Sometimes these artists attempt to carry on in illustration after graduation, but they seldom find it profitable enough.

Certainly, science schools today cannot offer lucrative employment to graduates possessing artistic qualifications for this work. Publishers can hardly assume the costs of elaborate new and original illustrative material for projected textbooks.

This returns to the author the responsibility for the illustrations for his manuscript, either by borrowing from others or by producing them himself.

Possessing sufficient artistic ability, the author often does a creditable job but at an economically prohibitive cost, considering the time taken out of a busy teaching or research schedule and employed in the unfamiliar task of making suitable drawings for reproduction.

Lacking talent, and admitting the lack, the author is now obliged to find students able to produce modified copies of figures in the literature. But note here two pertinent facts: first, supervising the production of suitable pictures requires artistic taste; and secondly, conception of suitable modifications calls for a definite creative skill. Many so-called modifications are only modified by poor copying.

An alternative course is to search for suitable illustrations in existing books and to ask one's publisher to borrow these from their copyright owners. It is not good salesmanship, from the publisher's point of view, to stock a book with pictures bearing credit-lines of competitors, even though the competitors are willing and able to lend them. This last may be clarified somewhat.

There is a wealth of good illustrations in the literature but much of it is inaccessible. This inaccessible material exists only as printed matter in out-of-print books whose plates are no longer in existence, and the same is true of the original drawings from which the plates were made.

But assuming that the needed drawing is still available there still remains the barrier of the copyright laws. The express permission of the copyright owner must be obtained in order to use it. He may refuse permission or he may grant it upon certain conditions. These invariably include printing with the illustration a credit-line variously worded. Whatever wording the copyright owner may dictate must be followed, and these credit-lines have been known to run into three lines of type. Obviously, a dozen repetitions of this will add considerably to type-setting costs. Legally, the same applies to the obvious modification or adaptation of such a drawing, although the practice of basing new drawings upon the framework of another's creative efforts is quite common, as a glance at the art-work accompanying new manuscripts would reveal. Fully one-third of such illustrations show unmistakable evidence of such questionable origin.

It would be unjust to condemn modern authors for such practices, because the reasons are valid, but something must be done, and soon, to correct the underlying factors.

(Continued on Page 111)

Vitamins by the Ton

● **By Paul J. Cardinal**
VICE-PRESIDENT IN CHARGE OF VITAMIN DIVISION, HOFFMANN-LA ROCHE, INC., NUTLEY, NEW JERSEY

Although vitamins are used by individuals in very small quantities, the production of a number of these dietary requisites by chemical synthesis is big business. Just how big you will understand more clearly after reading this interesting and timely article.

Large percentages of the nation's total production of vitamins A, B_1, B_2, B_6, C, E, biotin, and panthenol come from Roche Park, where the commercial scale production of synthetic Vitamin A has recently been started.

Here is an up-to-the-minute discussion of the synthetic vitamin situation. It contains valuable information not readily available elsewhere.

●

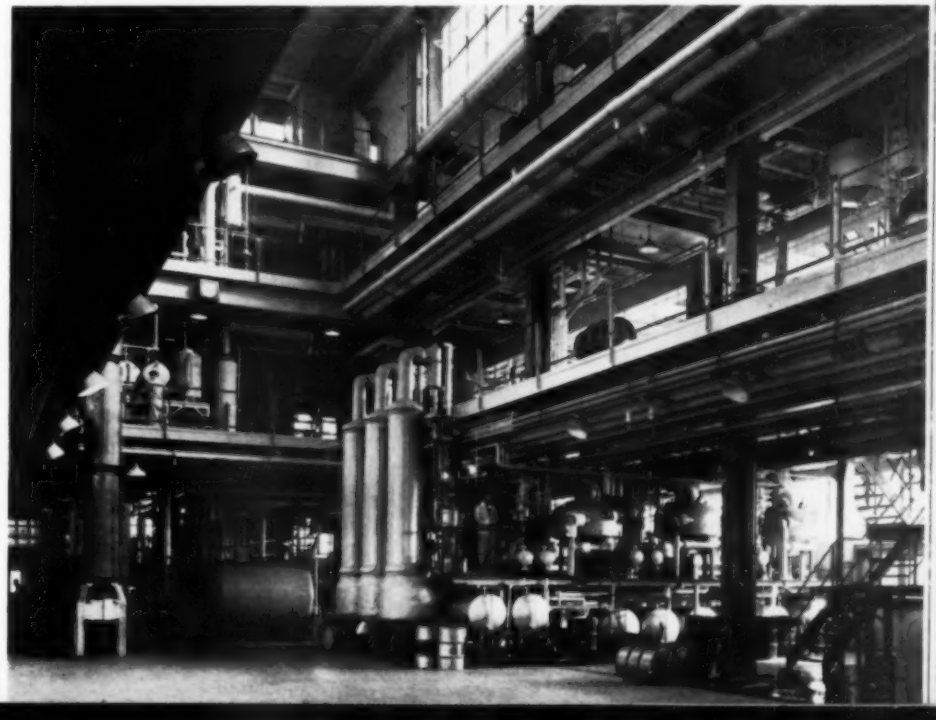
People to whom vitamins still are something of a mystery usually voice surprise when informed that weekly production in the United States over the past two years has averaged close to 2 tons of vitamin B_1, 10 tons of vitamin C and 11 tons of niacin. Production is reported by the U.S. Tariff Commission. Vitamin A, which until recently has been manufactured principally from fish liver and fish liver oils, required the importation of an estimated 800 tons of the latter per week and the maintenance of extensive fishing fleets.

These figures for manufactured vitamins obviously show general distrust of the old admonition, "Eat a balanced diet and you'll get all the vitamins you need." That distrust was finally shared by the Government itself when it included in the wartime educational campaign on behalf of eating "The Basic Seven," mention of flour and bread enriched with vitamins B_1 (thiamine), B_2 (riboflavin), niacin and iron. And that distrust grew to the point where War Food Order No. 1, effective January 18, 1943, required such enrichment of all white bread until October 18, 1946. Since that time 26 States, Hawaii and Puerto Rico have laws requiring enrichment of both commercial white bread and family white flour. Five Southern States require enrichment of degerminated corn meals and grits. Heeding evidence presented at Government hearings also, the Federal Food and Drug Administration has established standards for enriched macaroni and noodle products, for evaporated milk with increased vitamin D content and for oleomargarine with added vitamin A.

The foundation for vitamin enrichment of foods is laid upon firm ground and industry was well embarked on programs long before governments acted. Two decades of accumulating evidence had convinced leading millers, bakers and breakfast cereal manufacturers that modern highly developed milling and processing methods had taken nutritional value from their products. To put back what was then called vitamin B, cereal companies first added wheat germ or dried yeast, but after vitamin B_1 had been identified and made commercially available in 1936 the vitamin was preferred because it did not affect appearance, flavor or baking properties.

Programs then centered around "vitamin B_1 bread" and flour, and in December, 1938, a joint committee of the American Medical Association's Council on Foods and Nutrition and Council on Pharmacy and Chemistry endorsed the principle of vitamin restoration. Scientific studies of food handling, of kitchen practices and of eating habits proved the need for vitamin addition. Eventually the National Research Council's Food and Nutrition Board issued tables showing the amounts of vitamins and minerals considered adequate for maintenance of good health according to age, sex, and activity. The American Public Health Association endorsed the principle of vitamin addition, and after the Government had become actively interested the Federal Security Agency issued a statement of policy in July, 1943, saying "unenriched foods of the kinds and in the quantities necessary for adequate nutrition are not now available to substantial parts of the population" so that

VISITORS SEEING EQUIPMENT like this part of the vitamin A building wonder if they have entered a new Buck Rogers world.



appropriate enrichment of some foods "will contribute substantially to the nutritional welfare of consumers and to meeting their expectations of benefits."

One can spend many delightful hours studying the fascinating evolution of the modern concept of nutrition. If wheat berries, for instance, were ever eaten raw by early man, learning to cook brought desire for changes. Milling of grains is one of the oldest trades. The first bread, cakes and pies must have been as sensational as the atomic bomb is to us today. Milling is old but the degree of milling has undergone continuous development. People sometimes ask if today's white and beautifully fine wheat flour isn't an over refinement. They do not realize its superior baking properties, or how much better it stands up in modern market distribution than the former products which went rancid and made poor bread. They would have a different picture if they had been among the soldiers in the French Army whose complaints led military pharmacist Parmentier back around 1770 to conclude that "only bad economy can provoke us to include bran in our bread" and to promote introduction of white bread and its adoption by the French Army. Today's enriched white bread, to quote a May 15th editorial in *Bakers Weekly*, "has provided a direct and unequivocal refutation of the vicious slanders of the food faddists who too long had been permitted to monopolize public attention."

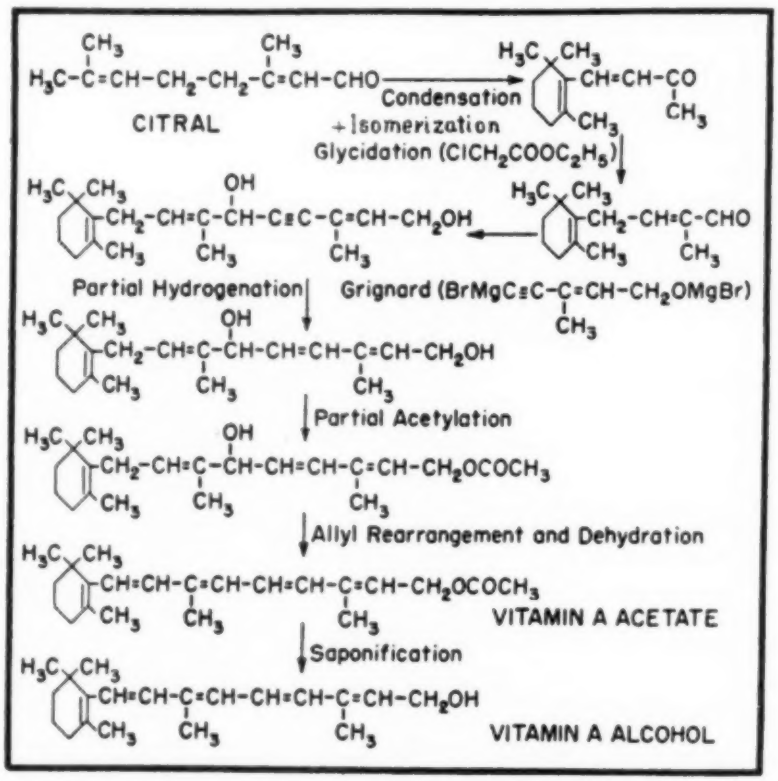
The word "vitamine," spelt at the time with a final "e," was coined in 1912 by Casimir Funk after various research investigations had proved that this group of food elements was essential to good health and physiologic function. Says the American Medical Association's Council on Pharmacy and Chemistry in the 1949 *New and Nonofficial Remedies*, "The absence of any one of the vitamins from a diet which is satisfactory in other respects leads to the development of a typical syndrome which is called a 'deficiency disease.' These diseases may be as striking in their manifestations as are the direct result of underfeeding (caloric deficiency) or deprivation of essential inorganic elements such as iodine, iron, calcium or phosphorus. A striking illustration of a 'deficiency disease' is presented by scurvy. This can be entirely averted or effectively cured by the inclusion of foods which contain vitamin C (ascorbic acid) in the diet."

The vitamin theory was conceived and developed to a great degree from studies of the "antiberiberi factor" which eventually was established as vitamin B_1 (thiamine). If further proof of the validity of the theory was needed it has now been furnished by a mass experiment involving some 90,000 inhabitants of the Philippines, conducted over a period of 20 months. Milled white rice, the principal food consumed there, is deficient in thiamine; so the vitamin was restored to all the rice consumed by one segment of the population, while comparative records were kept on a control group in an adjacent area. A medical report about to be published shows a very large decline in incidence of beriberi among those who got the vitaminized rice.

Addition of vitamins to foods takes one part of all the vitamins manufactured. A second great part is needed by pharmaceutical manufacturers who supply the capsules, tablets, elixirs, solutions for injection, and other vehicles needed by the medical profession in treating disease. Complete vitamin deficiencies such as scurvy and beriberi are not often encountered now in the United States, but medical knowledge has connected partial deficiencies of various vitamins with various conditions. To aid general practitioners in detecting these partial deficiencies the National Research Council's Food and Nutrition Board has sponsored a special new guidebook, *Clinical Nutrition*, just released, and the American Medical Association's Council on Foods and Nutrition will soon issue a revised edition of its own *Handbook of Nutrition*.

Doctors write many special prescriptions, depending upon the vitamin or group of vitamins needed. Pediatricians,

(Continued on Page 110)



MANUFACTURE OF VITAMIN A from Citral by a Twelve-step Synthesis.

Collecting Plants in Kodachrome

● **By Brother H. Charles, F.S.C.**
DEPARTMENT OF BIOLOGY, ST. MARY'S COLLEGE, WINONA, MINNESOTA

Photographing plants in their natural surroundings is a healthful hobby and a helpful avocation for science teachers. It requires judgment and patience but no major investment for equipment, and no greater skill than that commonly possessed by the enthusiastic amateur.

Brother H. Charles has learned by long experience how to make colored pictures in the field that will be useful in the classroom. Here he gives sound advice concerning cameras, light meters, focusing, shutter speeds, exposure time, composition, lighting, background, and other details.

●

Plants in bloom are wonderful examples of God's handiwork. To bring such wonders to the attention of our students effectively, to teach them to recognize the plants common to their region, and thus to promote a real enjoyment of the out-of-doors are primary aims of every enthusiastic biology teacher.

But how can we show the beauties of the field to the large classes assigned to most of us? To bring the students into the fields and there study living things in their natural surroundings would be ideal. But the locations of the schools and the growth habits of plants make this impossible. To pick and preserve the flowers is to destroy their beauty and attractiveness, and to further reduce an already badly depleted native flora. Yet, recognition of the local flora can be successfully taught.

We can step over these apparent barriers and introduce our students to the glories of plant life by means of a wise selection of colored pictures. Color films of most of the plants common to the United States in the form of 2" x 2" slides are now available at biological supply houses. Their price is reasonable. But to be most valuable the pictures should be made in the localities in which we teach, and by us, or under our directon. Such pictures are tailored to our methods of instruction, they are more easily and more completely interpreted since we have first-hand knowledge of the details included, and they are more helpful in inducing students to go out and get acquainted with the living things in their area.

Naturalness is a prime requisite of effective pictures. The more nearly our pictures look like the actual plants the better they serve in teaching our students to recognize them. Consequently, plants should be photographed where they grow. Though we are not conscious of it, reflections from their surroundings notably alter the colors of plants. In the spring, the brown color of fallen leaves gives a soft brown tone to spring blossoms. A color picture taken in the field records these reflections. It is more natural to the eye, and it is better suited for teaching purposes.

Out-door photography is not merely finding plants and making rapid exposures of them. If we are to produce pictures which exactly suit our purposes and of which we can be justly proud, we must be patient, deliberate and critical. The plants must be selected with care. They must be typical of their kind and as nearly perfect as possible. To determine the suitability of the picture, its composition and lighting should be studied through the viewfinder. The camera should be moved about until the view is exactly right. If no views suits, we should move on to other plants of the same kind growing in a slightly different situation. There is little use in taking a picture of a plant unless it portrays the particular characteristics we wish to accentuate.

The plant should be the point of chief interest in the picture. This may be accomplished by controlling the depth of focus, by trimming or removing the surrounding vegetation, or by using backgrounds made of colored cloths. When the first method is used, the sharpness of focus of the surroundings will depend upon their interest. If the habitat of the plant is of importance, and it usually is, the plant should be in slightly sharper focus than the surroundings. Such depth is easily secured if the lens is stopped down to about f.8. Where the plant alone is important the background should be in soft focus. However, care must be exercised to prevent large hazy masses which are distracting. The plant may be made to stand out in bold outline by removing most of the surrounding growth, or by using a colored cloth as a background. I do not like the reflections from such backgrounds and do not use them.

For photographing flowers I prefer a 35 mm. camera. It is easily carried in the field, and the images on the film are sharp enough for great enlargement with a projector. Its lens is corrected for color. Its range finder is convenient for sharp focusing. However, when supplementary lenses are used for closeups, the focus must be determined by measuring the distance from the lens to the plant. Most of my closeups are taken with the camera from 16 to 18 inches from the plant. Reflex type cameras are superior for studying the composition of the picture and for centering the point of interest. A lens hood should be used at all times to prevent haze resulting from stray beams of light.

Movement due to wind is sure to try the patience of any out-door photographer. Many times when other conditions for photographing are ideal, gusty air currents keep the plants in almost continuous motion. The slightest breeze may cause enough motion to spoil a picture because Kodachrome film is slow, and the open-

(Continued on Page 118)

Building a Betatron on a Budget

• By **Francis J. Jankowski, Sc. D.,** *(University of Cincinnati)*
FORMERLY, GRADUATE DEPARTMENT OF APPLIED SCIENCE, UNIVERSITY OF CINCINNATI.
NOW, BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

This is a story of how a 20,000,000 volt betatron was constructed at about one per cent of its normal cost from war surplus, donated, and inexpensive materials, by an enthusiastic scientist who is not afraid to work.

Dr. Jankowski designed and built the electron accelerator he describes, even twisting by hand the 300 foot, ⅜ inch cables of 49 strands of individually insulated wires.

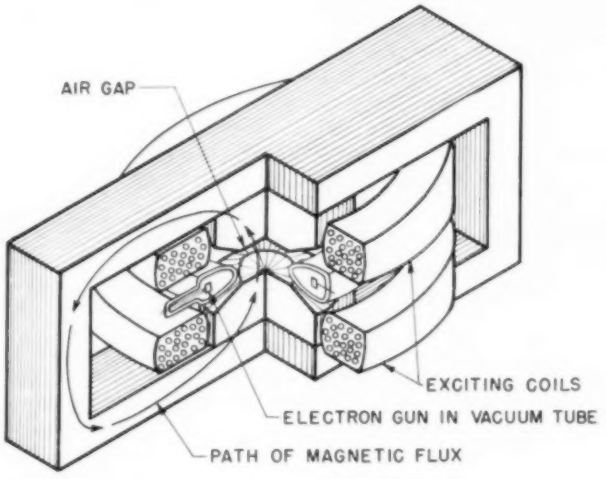
He explains the structure and working of this versatile machine which is used for carrying on fundamental research in nuclear physics.

The quest for knowledge concerning atomic nuclei has been paralleled by a quest for higher and still higher energy particles with which to bombard these nuclei. To produce these high energy particles many types of accelerating machines, some quite large and expensive, have been developed. At the University of Cincinnati, the interest centered on electron accelerators. A study was made of methods used to produce high energy electrons and high energy X-rays. After a careful consideration of the many factors involved, including our own capabilities and desires, a betatron was chosen.

The operation of a betatron may be best understood by comparing it to a transformer. The output voltage of a transformer is approximately equal to the input voltage times the ratio of the number of turns in the secondary coil to the number of turns in the primary coil. For example, if a transformer had a 20 turn primary coil and a one million turn secondary coil, and 400 volts were connected to the primary, we would expect to have 20 million volts on the secondary coil. Such a transformer would be impractical, however, because of the difficulties in winding the coils and in insulating such extremely high voltages. The betatron avoids these difficulties and obtains the effect of such high voltages by a rather ingenious means. In place of the million turn secondary coil, the electrons which form the electric current are allowed to circle the steel core a million times in evacuated space, thereby obtaining the same energy as would have resulted if they could have been accelerated by a 20 million volt potential in a cathode ray tube or an X-ray tube.

THE UNIVERSITY OF CINCINNATI BETATRON. The auxiliary electronic equipment is on the left. The hoist is for lifting the top to allow removal of the coils and vacuum tube. The vacuum pump on the right has not yet been connected. In the foreground is a Geiger-Müller counter with an electronic scaler. The two cables overhead lead to the condenser bank, which is used for tuning the exciting coils.

This method of obtaining high energy electrons had been known for a number of years, but the problems of making the electrons follow a prescribed path and of making them return to this path if they should wander proved more difficult. These problems were finally solved by Drs. Kerst and Serber at the University of Illinois. They showed that if



SECTIONAL DRAWING showing the principal parts of a betatron. *(Drawing by A. J. Schwarber, Jr.)*

the average magnetic flux density within a selected circle was twice as great as the magnetic flux density at the circle, the electrons would follow this circle. Furthermore, they showed that if, in the vicinity of the circle, the variation in magnetic flux density lay between the extremes of no variation and of a variation that is inversely proportional to the distance from the center of the circle, electrons straying from this circular path would be forced to return. To satisfy these conditions it is necessary to provide an accurately shaped air gap in the iron core for the electron path.

The electron beam current in the betatron is extremely small, so small that it may be neglected entirely when power requirements are considered. In this respect the betatron may be thought of as a transformer with no load. The only current being drawn is that necessary to overcome the losses in the steel due to eddy currents, and the small amount of power taken due to the resistance of the primary, or exciting coil.

However, the magnetizing current in the betatron is large because of the air gap. To prevent a large drain on the power line, the exciting coils are always connected to a bank of condensers which are adjusted to give a resonant, or tuned circuit. This circuit is tuned to the operating frequency of the betatron, much as a radio receiver is tuned to the frequency of the desired station. When this is done only the current required to overcome the losses is drawn from the power line.

Dr. Kerst applied the discoveries made by him and Dr. Serber to the betatron which he completed in 1940. His was the first successful machine. At the University of Cincinnati a similar betatron was started in 1947. There was little that was original or outstanding about this machine; little, that is, except the manner in which this project was accomplished. There were no large funds available, and no personnel experienced in this field. It was a new venture, and an exciting one.

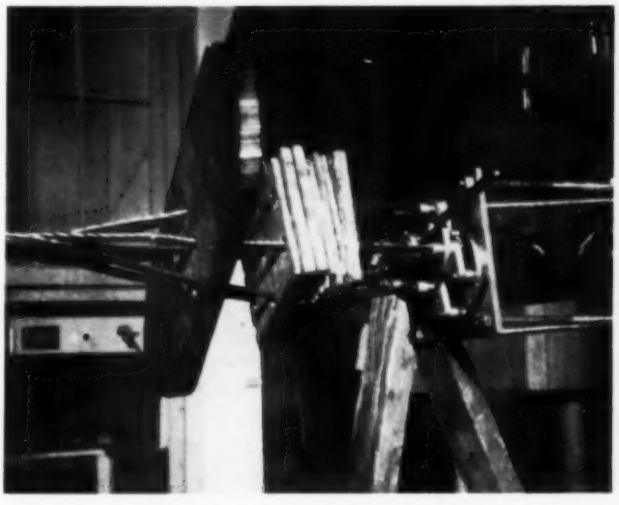
Twenty million volts was the size chosen for the Cincinnati betatron. It was to be operated at sixty cycles, the power line frequency. Cost considerations dictated this decision. Design calculations were made and a preliminary design of the coils and magnet drawn up. Final design depended on the materials available.

These design calculations revealed amazing facts about the behavior of the electrons in the betatron, as well as interesting data on the requirements for such a machine. The electrons would be accelerated during one quarter of the alternating current cycle, or one two-hundred-fortieth of a second. During the remaining three quarters of the cycle the machine would be recovering for the next electrons. Each electron that struck the target would have made over a million circles, traveling more than 750 miles. Most of this distance would be traveled at greater than 99 per cent of the speed of light. Their final energy would be forty times the value of their rest energy as given by Einstein's mass-energy relation.

The materials required for this machine were considerable for the limited budget for the project. They included three tons of transformer steel, nearly four hundred pounds of copper wire, and condensers to handle approximately 400,000 volt amperes. By using these condensers to take care of the high magnetizing current, the load on the power line would be but 8,000 volt amperes, or eight kilowatts.

The major portion of the steel was obtained from three old transformers given to the laboratory by a local firm. The steel for the part of the core containing the air gap was purchased. It was a high quality steel that would produce stronger magnetic fields. This special steel may allow the betatron to be operated ten per cent or more above the design voltage. A few thousand dollars' worth of condensers were purchased on the war surplus market for a few hundred dollars. The copper wire was also purchased from war surplus,

(Continued on Page 108)



WIRE TWISTING EQUIPMENT being used to make the cables for the betatron coils. The board on the left and the metal assembly on the right were both turned at the same rate by two persons. The wood blocks in the center were to keep the strands from tangling when the two twisting units were 75 feet apart.

The Nutritional Approach to the Prevention of Disease

• By J. F. Wischhusen.
DIRECTOR, MANGANESE RESEARCH AND DEVELOPMENT FOUNDATION, CLEVELAND, OHIO

and N. O. Gunderson, M.D.
COMMISSIONER OF HEALTH, CITY OF ROCKFORD, ILLINOIS

This article will stimulate thought, and we hope, discussion and research.

All who read it will not be convinced immediately that the authors are entirely correct in their conclusions. There is ground for opposing opinions. But right or wrong, the matters considered here are important enough to deserve the careful consideration of everyone concerned.

●

Louis Pasteur, the famous French scientist, established the now well known doctrine that certain bacteria or other microörganisms known as pathogens are the immediate cause of disease. From this knowledge developed the method of destroying the microörganisms by pasteurization, which is equivalent to the destruction by heat of certain lower forms of life. Practically no living organism, including man for instance, can exist in water that is brought to a boiling temperature, but each form of life is killed at different degrees of temperature. Temperature can be thought of as the universal cure for disease by its ability to destroy disease germs. It would be ridiculous to practice this. The general public now seems to rely entirely on pasteurization to prevent the spread of disease, as far as milk or other beverages and food are concerned.

It should be pointed out that pasteurization is neither a cure for, nor a prevention of disease, but only an expedient to destroy the disease germs that already exist in foods, particularly milk. Pasteurized liquids are expected to be consumed promptly for fear that bacteria not destroyed at a temperature of 145° F. will multiply and occasionally cause infection. The public has furthermore come to believe that "bacteria are the primary cause of disease." It is high time that alongside of this concept there is stated another important doctrine; viz: — **Practically all disease is preceded by malnutrition,** and that the absence of any one essential element will lead to disease. Malnutrition is followed by disease and often accompanies the progress of disease. A growing number of diseases are frankly and almost universally recognized as resulting from nutritional deficiencies.

Modern bacteriology has gone a step further and developed Pasteur's other method, namely to counteract or destroy bacteria by vaccination and the use of antibiotics. The principle of vaccination is probably known most generally from the fact that by the inoculation in a more or less modified form of the pathogen that apparently causes the particular disease, a variable degree of immunity to the disease is created in the animal body.

When live or dead organisms are injected, or enter the body in the course of a disease, a variable degree of active immunity is created through the development of antibodies by the blood of the host. The antibodies are formed from the globulin normally present, and they serve to enhance the effect of natural defense mechanisms. This protection process is one phase of a broad physiologic natural function of the body directed toward the elimination of both animate and inanimate particles foreign to the body. Many believe that these natural mechanisms of the body were originally related in the evolutionary process to the ability of the body to absorb and assimilate material for nutritional purposes.

The normal blood serum contains substances called opsonins that also act upon bacteria and prepare them for ingestion or *phagocytosis* by normal leucocytes. Phagocytosis is not an individual activity but one in which many of the different body fluids take part. Normal blood sera also possess the power in the presence of the complement to cause *lysis* or disintegration of some species of bacteria. The active immunity for certain diseases resulting from immunization with antigen, or from natural recovery from certain diseases, usually persists for a considerable time. A second type of immunity is called passive and is of short duration. Antigens injected into animals also produce antibodies, and when such immune serum is injected into individuals the protection conferred is temporary since it was made in an animal body, and not actively produced by the individual receiving it. Hereditary factors also influence an individual's resistance to certain diseases. This has been demonstrated with mixed-bred and inbred races of test animals.

When the nutritional needs of a person have been inadequate, the various kinds of bacteria that may initiate disease processes under such conditions will be found to differ widely in their toxicity and in their ability to break down the body defenses. The qualities of toxin production and invasiveness, that vary from excessive amounts to none with the different species of organisms, will also differ among different strains of the same species. Some of these toxins are extremely poisonous even in small amounts. Radical changes in an organism can be brought about simply by altering the conditions of growth and the environmental factors. Bacteria have a wide range of adaptation that affects their ability to survive in different environments.

A vast amount of experimental work has been carried on in the field of bacteria versus antigens and antibodies as they may affect immunity and resistance to disease. Only recently have investigations been initiated to determine the part that nutrition plays in relation to resistance to infection. Studies of this kind all strongly indicate that not only the inorganic nutrients, commonly called "minerals," that include trace elements and more abundant inorganic chemical compounds, but also the organic nutrients referred to as amino acids, vitamins, and hormones, have a most important and fundamental bearing upon the health and disease resistance of both animals and man.

Scientists have been almost entirely preoccupied by the concept that bacteria cause disease, rather than by a much more important concept that adequate nutrition causes good health and relative freedom from disease. It is certainly more logical to prevent disease from occurring insofar as this is possible, rather than to concentrate exclusively on ways to repair the damage after it has occurred. The first concept has been greatly overemphasized, and the latter has been greatly minimized and neglected. Is it better to have a relatively stable natural nutritional immunity, or a sporadic, irregular, synthetic, specialized type of artificially induced immunity?

A still more modern phase of science concerns the use of *antibiotics*. This refers to the employment of certain drugs, products from molds, or anything that acts as a poison to the disease organisms, in the hope that it will do no other damage to the host itself. It must be remembered that in all these measures there is to begin with, an animal or human body that is often weakened by malnutrition, and therefore favorable to the invasion of the disease organisms which as stated,—are also referred to as pathogens. We therefore deal with a situation in which a poorly constituted body, unable to resist the invasion of disease, has introduced into it by vaccination modified forms of the very disease organism it is calculated to destroy. A bad situation is made worse. In the case of milk, pasteurization destroys both disease organisms and beneficial organisms, as well as some of the vitamins and hormones, anything that is weakened or destroyed at the temperature reached by pasteurization. We therefore end up by consuming milk that is partly pasteurized "bug juice," or eat meat that contains dead bacteria in a "cooked" condition. That these dead germs can sometimes be toxic to an unsuspecting public that likes its milk pasteurized, and its meat cooked in the form of "hot dogs" and "bologna," is nowhere stressed. Then we wonder why such degenerative diseases as "rheumatism," "arthritis," "gastro-intestinal disorders," "nervous and mental diseases," "cancer," etc., are on the increase and defy treatment. Most of us are consuming substandard foods, and consequently have substandard health in a more or less indefinable manner.

Now let us look at the other side of the picture and ask why there are some people and animals in apparently perfect health? Surely not by the use of medicines because a healthy body rarely if ever, requires any. Nor by first allowing disease germs to invade a body that is in a weak condition, then to destroy them therein with more disease germs under the heading of vaccines, drugs, or other poisons on the theory that we "cure" disease. Surely it can be seen that vaccination and the use of antibiotics at best have merely counteracted an already bad situation. It hasn't changed a poor and diseased body into a strong and healthy one!

Where then do healthy bodies come from? There can only be one answer, viz: from correct, adequate and suitable nutrition. This may have its roots in prenatal care, viz: the nutrition supplied to the foetus by the mother. From birth on, the quality of the total food ingested determines good health or poor health. The quality of the food is again determined by the quality of the nutrients, and all pertinent factors in the soil on which it is grown, or in any and all other sources of origin such as the sea and the atmosphere.

The biochemical composition of healthy animal bodies, those that are naturally in optimum health, production and reproduction, is ascertainable by various analytical methods. It will be found that the composition of healthy bodies is relatively constant, and that the standards thereof can be adopted. The deviations from such standards of *animals on a high plane of nutrition*, can be ascertained by using the same methods of analysis on the bodies of animals that are on a relatively *low plane of nutrition*: those that are sent to slaughter because sick, unthrifty, sterile or aged. The differences between the two are the true primary causes of disease, because they take precedence over the invasion of the pathogens. Disease germs almost always invade bodies that are unfit, and therefore are a secondary cause of disease.

The purpose of disease may be said to be the removal of the unfit. Remove the true underlying cause of disease, *malnutrition*, and it will usually be found that the disease germs cannot exist or propagate in an animal body that is healthy. Germs are never entirely eliminated, only counterbalanced, depressed or inhibited in their growth and reproduction. Therefore the inhibitors, whatever they are, concern the control of disease. We must learn to activate the beneficial microorganisms in the animal body so that they will outnumber and therefore tend to subdue the detrimental organisms, those that many people assume are the one cause of disease and that are known as pathogens. Beneficial organisms are those that stimulate enzyme reactions which function in the formation of balanced proteins, blood pigments, respiratory pigments, and finally aid in the production of vitamins and hormones.

In regard to brucellosis and mastitis, there was undertaken in Cleveland in 1939 spectroscopic analytical work, comparing the composition of the blood and the pituitary of cows sent to slaughter as Bangs reactors, with the composition of healthy cows. This led to the discovery that the diseased animals had less manganese, copper, cobalt, and zinc than the healthy animals. To prove these analytical findings in a practical way, compounds of these trace elements, which fall in the

(Continued on Page 112)

Big Trees and a Camera

• By S. Glidden Baldwin, M.D., F.A.C.S.
PRACTICING PHYSICIAN, DANVILLE, ILLINOIS

Physicians more than others realize how necessary it is to have a hobby that will provide pleasure, relaxation and a change of occupation. Dr. Baldwin has followed wise counsel in developing a special interest in the discovery and photographing of the country's largest trees.

His unusual hobby is described in this brief article.

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Everybody should have a hobby if he hopes to live a long time. There is nothing that relieves tension better and nothing more conducive to longevity than an outdoor hobby. For my part, I prefer to study nature in some form.

I have never been able to figure out whether the love of trees started me photographing them, or whether photographing trees taught me to appreciate them. But the fact is, I have spent a lot of time and have had much fun in the fields and woods with my camera, or I should say, cameras.

America was rich, rich in natural resources, when the white man first came to her shores. Her greatest wealth lay in her forests and her soil. The trees were so large and the stands so dense that the early settlers often recounted how the shade of the trees prevented them from seeing the sun even at high noon. But, alas, our virgin forests are gone. Many of the trees were built into homes and other buildings, but many more were burned just to make way for agriculture. One shudders when he reads accounts of the early log rollings, and the huge bonfires of walnut trees that were burned to get rid of them. What were these trees like? How big were they?

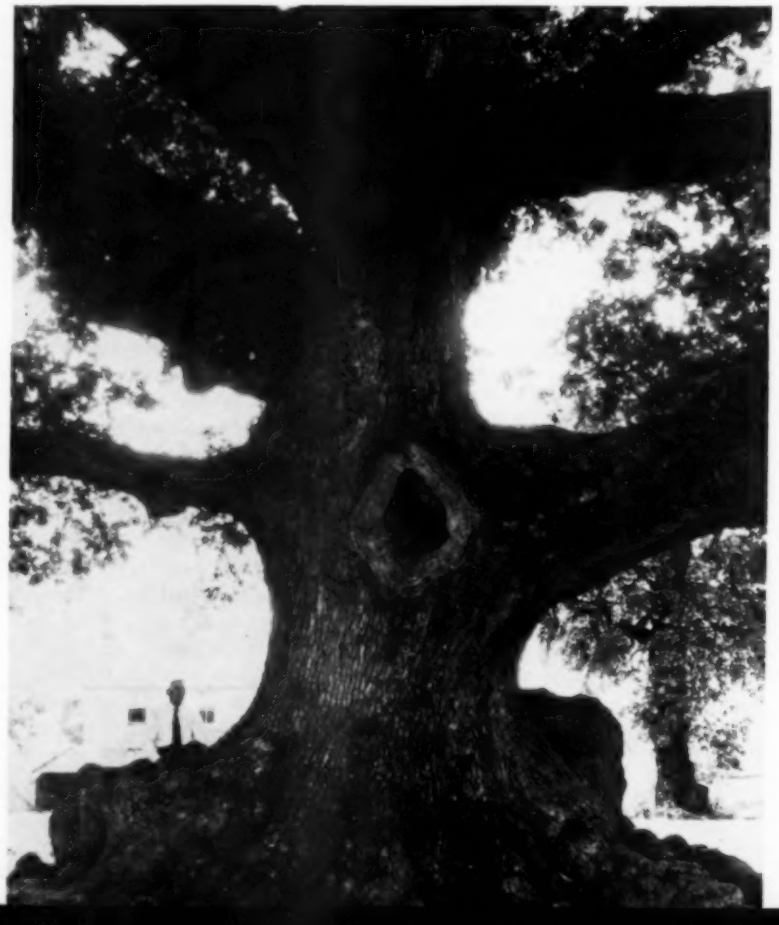
Fortunately, a few are still left, a very few living trees of these wonderful virgin forests, such as man had never seen before nor will ever see again. These trees are scattered here and there throughout the United States, more being found in the eastern half than elsewhere.

My latest hobby has been photographing these big trees, each the largest of its species that I could locate. This project, of course, is not finished, and probably never will be as more great trees may yet be discovered, but the continued hunt with tape and camera adds zest to the hobby. To date, I have been able to record more than 65 trees, each the largest of its kind in the world. A few of the trees I have found are pictured here. Space was not available for more.

THE WYE MILLS OAK

THIS LARGEST and probably oldest of white oak trees (it is known to be over 400 years old) is found along the highway in a small state park in the village of Wye Mills, Eastern Shore, Maryland. The circumference, breast high, is 27 feet 8 inches and it has a spread of 165 feet, more than one half the length of a football field. The height is 95 feet.

The unusual knees or burls at the base of this tree have been the subject of much controversy. Could it be that horses hitched to this tree years ago could have pawed or stomped at the roots or lower trunk, and the tree in repairing its injury produced the knees?



But now my photographic project has turned into a crusade, a crusade to save these largest trees. I would like to see established a living museum of trees. Local societies, city governments, state and federal governments have established all kinds of museums, parks, zoos, monuments, cemeteries, and collections and memorials that are of interest either from a historical or a scientific standpoint. Much money has been spent to build museums to house many dusty objects of a bygone era. We all like to see these objects, these his-

torical remnants of past generations, the dinosaurs, the Egyptian mummies and the boats of the Norsemen; but think of the opportunity we have to preserve at much less expense the big trees that are living survivals of America's greatness. These are not dead and preserved specimens, but still living testimonials of the natural wealth that was America's, these last few remaining trees representative of the virgin forests that stretched so endlessly north, south and west when our pioneer forefathers landed here.

Pursuing my hobby, I have located most of these very large trees. I have taken pictures and measurements of them, and I have recorded directions for finding them. I should like to propose that these trees, or as many of them as possible, be set aside as public parks so they may be preserved for all, especially for our children and for the coming generations. Much has been accomplished in the West by the "Save-The-Redwoods League," but nothing has been done in the East, except in a very few cases.

Let's organize some form of a "Save-The-Redwood League" for these last few giants, these champion trees, that represent the last remnants of our virgin hardwood forests. ●

Problem-solving

"There is no simple pattern or routine of problem-solving which can be isolated and taught in the schools as a simple unitary skill. Rather, problem-solving is an integration of a host of more particular knowledges, skills, and attitudes with which the schools can appropriately be concerned. A wide range of interests and experiences, an organized and functional stock of background information, efficient skills for locating and organizing needed information, perseverance yet flexibility in attacking problem situations, a willingness to suspend judgment until the evidence is in, habits of testing critically any purposed solutions, attitudes of critical appraisal of the reliability and bias of sources, skill in 'if—then' thinking—these and many more are the qualities which the school must try to develop if it is to improve problem-solving ability in its pupils."

—ROBERT L. THORNDIKE
Columbia University

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"Science is nothing but developed perception, interpreted intent, common sense rounded out and minutely articulated."

—GEORGE SANTAYANA

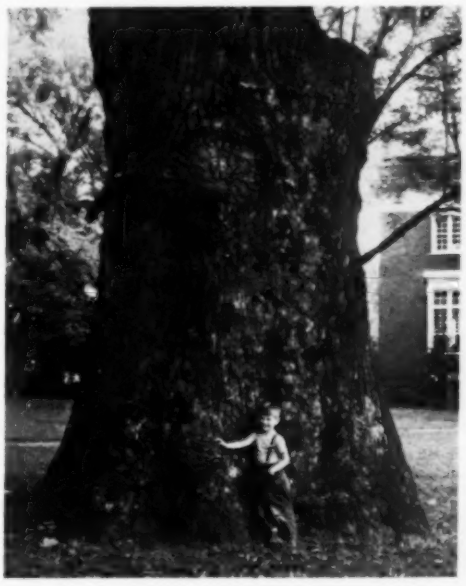
GREAT OAK OF LLOYD'S NECK—(Above)

THIS MAGNIFICENT black oak graces the home of Mrs. Myra R. Savage on Lloyd's Neck near Huntington, L. I., New York.

The dark green shining leathery leaves of this oak hold one's attention even after the beauty of its perfect symmetry has faded from one's consciousness. Certainly there are no prettier oaks than this one. A Long Island landmark for several centuries. It measures 19 ft. 5 in. in circumference, breast high, 4½ ft., and fortunately is guarded zealously by its gracious owner. This is the largest of black oaks. It is worth a pilgrimage to see it.

ANNAPOLIS TREATY TREE—(Below)

THIS UNUSUALLY large tulip tree measuring 26 feet 6 inches in circumference breast high (4½ ft.), is the largest tulip tree in the world. It adorns the campus of St. John's College at Annapolis, Md. St. John's College was founded as King William's School in 1696. Its fortunate location probably saved it. Some few people remember it because of its historical significance, for it was here in 1652 that the early settlers made their peace treaty with the Susquehannock Indians which permitted peaceful settlement of this area. In 1783, George Washington came here after the Revolutionary War to resign his commission as Commander-in-Chief of the Continental Army. He loved this tree so much that he revisited it in 1791. General Lafayette, his friend, was entertained and rested beneath its branches in 1824.



A TREE IN A MEADOW—(Above)

PEOPLE just don't believe that wild black cherry trees grow to be this big. The reason, of course, is that they have been so valuable for their pretty wood (used so much in antique furniture) that most of them were selectively cut from our eastern forests even before the ordinary lumber trees were felled. This beauty measures 18 ft. 4 in. in circumference, breast high. The author's wife is appraising its massive trunk. Note the fluted base which makes it more sturdy. The tree is located on the farm of Henry Rasin near Worton, Eastern Shore, Maryland.

How Did Life Originate?

● By **Lillian L. Imperi, B.S.,** (*Marygrove College*)
MARYGROVE COLLEGE, DETROIT, MICHIGAN

This paper was written by a recent science graduate who expects to study medicine.

She reviews the several theories of the origin of life that have at various times been seriously considered, and examines the evidence in favor and against each theory. Miss Imperi concludes, of course, that on purely scientific grounds no satisfactory explanation has yet been found.

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Life — how did it originate? This question has baffled theologians, philosophers, and scientists all through the centuries from antiquity to the present day. The theologian is guided by revelation in setting forth his theory of the origin of life, the theory of special creation. The philosopher reasons back to an Uncaused Cause which created the universe and the life in it, squaring his theory with scientific facts. The scientist, however, has to develop his theory in accordance with facts acquired by observation and experimentation.

Scientists know that the earth was too hot at one time to permit the existence of life. Therefore, evolutionists concluded that life was brought to earth from another planet, or that it originated on earth from inorganic matter. The theory that life originated from inorganic matter is the theory of abiogenesis, which was prominent from antiquity until the time of Pasteur and still claims a few modern adherents. The latest theory to be propounded regarding the origin of life concerns the virus, which is considered the "missing link" between the living and the non-living. At present, there is little or no scientific proof that the living evolved from the non-living. If, however, it is ever proved that organic matter originated from inorganic matter, the fact will not be opposed to Christianity, as many believe. Rather, the omnipotence of God would be more evident if He endowed matter with power to develop from an original state of chaos to the state of order and complexity which exists today.

The theory that life came to earth from another planet has no evidence to support it. Liebig, Helmholtz, and Kelvin, the most famous adherents to this theory, believed that life came to earth on meteorites when our earth cooled sufficiently to provide a suitable environment for the existence of life. Thousands of meteors reach our atmosphere each day, but many disintegrate before they can reach the ground. There is no proof that primitive "germs" of life exist on those which do reach the earth. Besides, radiations in space, the heat generated by a meteor in its travel through our atmosphere to earth, and the extreme cold of interstellar space would not permit the survivial of life. Furthermore, if it were proved that life was transported to earth from some other planet, we would still have to ascertain its origin on that planet.

Since there is no evidence to support the theory that life originated on another planet and was brought to earth on meteorites, let us examine the theory of spontaneous generation, the alternate theory, which, as we shall see, also lacks evidence. Turn back the pages of time and examine why Aristotle and other philosopher-scientists believed in spontaneous generation. Science was then not highly developed, and there were no microscopes with which to observe smaller organisms. Is it any wonder that men thought life came from mud when they saw frogs emerge from it? Or that burrowing rodents came from earth in field and forest? Even in the seventeenth century, Von Helmont believed that mice came from a pile of dirty rags and wheat kernels. These beliefs seem absurd to us today; however, it was not until 1698 that spontaneous generation as a theory was first discredited.

In 1698, Francisco Redi conducted his famous experiment which struck a telling blow at the theory of abiogenesis. He concluded that life came from preexisting life when he observed that worms developed from eggs laid by flies rather than from decaying meat. Thus, the theory that life came from dead or inorganic matter was abandoned for a time.

The advent of the microscope, however, revived the theory of spontaneous generation. It was observed that microscopic organisms appeared wherever fermentation or decay occurred. It was then believed that the decaying material gave birth to new organisms. Joblot, Needham, Buffon, and Spallanzani used boiled broth for experiments to either prove or disprove the theory that the organisms arose spontaneously. Spallanzani made the most telling experiments and proved that spontaneous generation did not take place in organic liquids. However, a theory which had been held for centuries by influential men, notably Aristotle, failed to die so easily.

It was not until Pasteur entered the scene that spontaneous generation was disproved as far as is possible. He proved that the air is filled with innumerable microorganisms which develop when they find a suitable medium. He showed that the instruments used by previous investigators also had microorganisms on them, and that spontaneous generation appeared to be proved when in reality poor techniques were used. He proved that if liquids were heated sufficiently to kill all microorganisms present and were sealed against infection from the air, the microorganisms would not appear. It is precisely this technique which is used in the canning of fruits, vegetables, and meats today. As Windle states in *Facts and Theories*:

(Continued on Page 114)

Seventy-five Years Young —

The Oldest Agricultural Experiment Station in America

• By C. L. W. Swanson, Ph. D., *(Iowa State College)*
CHIEF SOIL SCIENTIST, CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

Seventy-five years young well describes America's oldest agricultural experiment station.

Brief as its history is, the Connecticut Station's influence on agriculture in the state and nation, even in the world at large, is incalculable. The results of the Station's studies and researches on soils, tillage, food crops, fertilizers, forests, and many other phases of agriculture find useful applications everywhere.

You will be interested in this story of the achievements of a great institution where "Research is our business—discovery our product."

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This year the oldest agricultural experiment station in America celebrates its 75th birthday.

At seventy-five, people are old, ready to take it easy, let the younger generation tackle the new problems of the day. Not so for the Connecticut Agricultural Experiment Station. Scientists of the Station are continually at work testing new ideas and new methods for the improvement of agriculture.

Professor Samuel W. Johnson, founder of the Connecticut Agricultural Experiment Station and pioneer agricultural scientist, gave birth to the idea of agricultural experiment stations shortly after 1850. In 1875, the Connecticut General Assembly passed a law creating the Connecticut Agricultural Experiment Station, the first institution of its kind in America. This marked the beginning of making a "regular business of discovery" for agriculture—one of Professor Johnson's memorable quotes. As Director of the Station from 1877 to 1899 he made research the regular business of the Station, and discovery its product.

Much has happened in those 75 years. Tremendous strides have been made in agricultural research. Connecticut's example was soon followed by other States, and within fifteen years each State had established its own agricultural experiment station. The combined budget of these stations in 1949 totaled 52.5 million dollars. The combined benefit to American agriculture resulting from their efforts is beyond computation.

Dr. Johnson's first valuable work after establishing the Experiment Station was the analysis of commercial fertilizers. For years, Connecticut farmers had been unmercifully defrauded by unscrupulous dealers who sold "fertilizers" that were little more than dirt. The publicity given to the Station's analyses was relied on as the only means of controlling the quality of the fertilizers sold. This approach has been particularly successful through the years as shown by the 1949 inspection report that 89 per cent of all fertilizer guarantees were met or exceeded.

Director Johnson had a great interest in soils and plants. In his first Experiment Station report, written with an Edison electric pen, he wrote extensively on the physical and chemical properties of soils. He discussed the reasons for tillage, and emphasized the importance of the falling raindrop in the compaction of the surface soil as a result of the impact of the drop and the clogging of the surface pores by the dispersed silt and clay. It is of interest that nearly 75 years

MAKING SOIL SURVEYS requires a detailed examination of soils. Among soil properties studied are depth, workability, color, erodibility, and productiveness. Here D. B. Downs (left) and C. L. W. Swanson (right) examine a soil as part of the work in making a detailed soil survey of Hartford County. Soil maps are in demand for land use and conservation farm planning work.

later soil scientists with high-powered cameras and split-second timing apparatus actually took pictures of the action of raindrops and showed Johnson's ideas to be correct. Experimental results of the Station's Soils Department recently corroborated his views. Puddling of the soil surface by hard rains was largely responsible for a 40-bushel reduced corn yield, in contrast to corn cultivated to break the crust. He also wrote about seed testing, analyses of hay, use of peat for crops, analyses of fertilizers, etc.

In addition to being Director of the Station, Johnson was also professor of agricultural chemistry at Yale University. Before the Station was organized he wrote two books, one entitled *How Crops Grow—A Treatise on the Chemical Composition, Structure and Life of the Plant* and another called *How Crops Feed—A Treatise on the Atmosphere and the Soil as Related to the Nutrition of Agricultural Plants.* The first was published in 1868 and the second in 1870. Several editions of each appeared and they were translated into several languages. Sir John Russell, the famous Director of the Rothamsted Agricultural Experiment Station, the oldest agricultural experiment station in the world, used these books as source material for the writing of his authoritative book *Soil Conditions and Plant Growth* first published in 1912.

Space limits going into detail on the many and varied discoveries obtained by research techniques at the Connecticut Station for the betterment of agriculture, not only for Connecticut and the United States but for the world itself. Only a couple of the research finds will be elaborated on here.

One famous and comparatively well known example is the work of Dr. D. F. Jones in the development of the first "double cross" method of producing hybrid seed corn. In one generation, hybrid corn spread across the continent like wildfire, once it was made commercially available in the 'thirties.

With an estimated increase in yield of 20 per cent for the United States, use of the higher corn yielder helped conservation of our land, too. More could be produced on fewer acres and the poorer land retired to grass and tree crops, and more of the land in row crops rotated with grasses and legumes. Soil erosion would be better controlled and fertility of the land increased. It has been estimated that over 12 million additional acres of open-pollinated varieties would have been needed to produce as much corn as the 67 million acres planted to hybrid corn in 1949. The additional yearly value of this corn crop is estimated at close to a billion dollars.

The late Dr. M. F. Morgan's work on soil testing is another notable piece of research. He was the first individual to make soil testing practical, so that many soils could be tested quickly, easily, and cheaply. He found a chemical solution that simulated the action of plants in taking up nutrients from the soil. Morgan devised a series of tests to include all of the major and secondary nutrients required for good plant growth. Results from his tests showed which kind of fertilizers should be used and how much, thereby eliminating waste of fertilizers and also insuring larger crop yields. Today his test procedures or modifications of them are used extensively in the United States and in many foreign countries. It has been estimated that the worth of his tests amount to a million dollars annually in Connecticut alone.

Seedtesting, spraying to control plant disease and insects, soil science, tobacco culture, forestry, studies in protein chemistry, early studies in chick nutrition, fertilizer inspection—those and many other problems of agriculture have engaged the expert attention of the Station scientists. "Research is our business—discovery is our product"—is their motto. Publication of some 20 bulletins a year by the Station, writings of the staff in scientific journals, press releases, and a twice-yearly issued popular account of the Station's findings in *Frontiers of Plant Science* keep Connecticut citizens and scientists world-wide informed of the research products of the Station.

Plans are already underway for a year-long celebration of the diamond anniversary with various Connecticut agricultural organizations and several scientific societies holding their annual meetings at the Station in 1950. A special event includes a two-day celebration on September 28 and 29. The first day will include an open house for the general public at which time each department will high-light its work. In the afternoon, Mr. Arnold Nicholson, Managing Editor of "The Country Gentleman," will address the visitors on the subject, "Why an Agricultural Experiment Station?" Scheduled for the evening is a talk entitled,

(Continued on Page 118)

STREAM-LINED SPRAYING of experimental plots which are arranged in a spiral, with spray boom, hose and light bike-tired spray nozzle.

Tin is a Useful Metal

● **By Robert M. MacIntosh, B.S.,** *(Polytechnic Institute of Brooklyn)*
SUPERVISOR, CHEMICAL DEVELOPMENT, TIN RESEARCH INSTITUTE, INCORPORATED, COLUMBUS, OHIO

Everyone knows tin because it has very common uses, but few persons are aware of the full extent of its many and varied industrial applications.

This well documented article deals with the production of this valuable metal, its properties, and its use in tinplates, solders, alloys, collapsible tubes, bearings, and in many other ways.

●

Although the annual world production of tin is seldom over 200,000 tons—small in comparison with that of iron, copper, lead, and zinc—the uses of tin are perhaps more widely spread industrially than those of any other metal. Since the earliest history of civilization, tin and its alloys have played an extremely vital part in industrial development.

The first application of tin was as an addition to copper, and, during the Bronze Age, a really effective material was available for a wide range of tools and weapons. Iron came into use and displaced bronze from these basic uses for a time, but later bronze in the form of bearings, gears, and tubes became closely associated with steel in the progressive development of the steam engine. The initial association of tin with copper was supplemented by association with other various white metals. These tin alloys furthered the development of the gas engine and internal combustion engine. Tin, in association with lead, became the essential material for jointing copper conductors and cables, which led to the remarkable applications for electricity in telegraphy, telephony, and radio transmission.

One of the most important events in history was the introduction of printing by means of movable type, which was made of alloys of tin.

An excellent discussion of the early history and metallurgy of the metal is given in the book *TIN* by C. L. Mantell[1].

Sources of Tin

As early as 1500 B.C., the Phoenicians were trading with Cornish (British) miners for tin. At the present time, tin ore in the form of the oxide (cassiterite) is mostly obtained from Malaya, Indonesia, Bolivia, Belgian Congo, Nigeria, and from Siam, China, Indo-China, Britain, Australia, Spain, etc. These areas account for 97 per cent of the world's tin output.

The alluvial deposits of the Malaya, Indonesia, Nigeria, and Congo are profitably exploited by efficient dredging methods from deposits containing as low as 1 part tin oxide in 10,000 parts of eluvium. The significance of this is better understood if one realizes that a single dredge with a capacity of 5 million cubic yards annually is capable of recovering 6-8 ozs. of tin from a cubic yard of soil (3,000 lbs.).

In the lode or deep rock mining areas of Bolivia and Cornwall, improved concentration methods have been introduced to ensure effective separation of the tin-rich material from associated impurities.

Statistical information on the production and consumption of tin is published monthly by the International Tin Study Group, The Hague, Holland. It is from this source that the information given in Tables I and II was obtained.

The smelting of tin ore underwent an evolution from primitive methods to blast furnace methods in the early industrial life, but is now usually carried out in large reverberatory furnaces under scientific control[1]. The final stage of refining has advanced to such a degree that exceedingly pure tin can now be obtained in continuous and plentiful supply. The principal tin smelters and refiners and typical compositions of their brands of tin metal may be found in *Metals Handbook*, p. 1064, 1948 Edition, American Society for Metals.

Tinplate

In order of importance, tin as a coating material for mild steel finds its greatest outlet in the manufacture of containers for food cans, tin plate wares, and dry packaging. Tinplate, which consists of mild steel coated with a thin layer of tin (0.000015-0.0001 inch), is suitable for use in a wide range of corrosive conditions. Steel is an ideal material for mass production of all kinds of articles for industrial and domestic use. Tin-

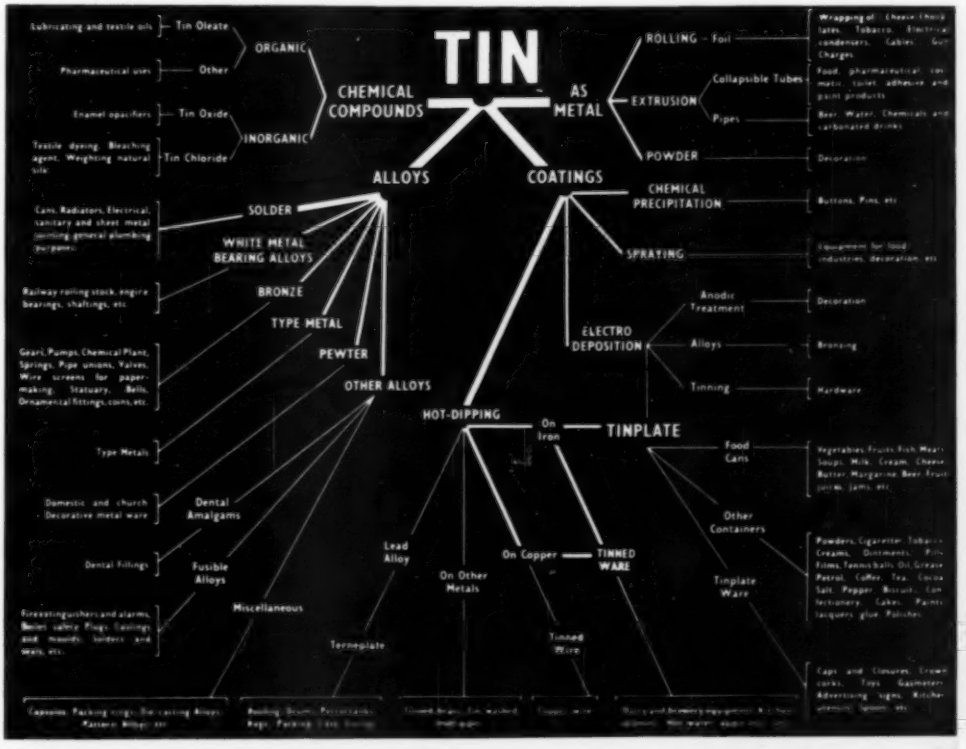

plate containers can be formed without adverse effect on the brightness and smoothness of the tin coating.

A wide range of tin coating thickness to meet every requirement of corrosion resistance can now be applied to steel sheet by continuous high-speed electrolytic lines and by hot-dip tinning machines. Hot-dip tinplate has a coating averaging 1.2 lbs. per base box (112 sheets, 14 × 20 inches) and is used in making cans for products which cannot be safely packed in the more thinly coated electrotinplate. Electrolytic lines, which produce about 50 per cent of the United States tinplate at tinning speeds as high as 1400 feet per minute, are limited for various reasons to coating thicknesses of 0.25 to 0.75 pound per base box. These more thinly coated grades have many can making applications, but protection must often be enhanced by the application of a coat of enamel or lacquer.[3, 4, 5, 6, 7]

Research laboratories of the steel industry and canning manufacturers have contributed greatly to the quality of tinplate, particularly on the important questions of steel chemistry and properties. Factors affecting the quality of electrolytic tinplate were recently summarized by Angles, Caulfield, and Kerr[2]. Improvements in the treatment of tinplate to increase the corrosion resistance and discourage staining have been developed by the Tin Research Institute[8] and by R. A. Gillies[9].

The merits of the tinplate container speak for themselves when one realizes that billions of cans are used by the canning industry each year. Speeds up to 375 cans per minute are not uncommon in can manufacturing lines.

Solder

In the joining of metals, tin-lead solders are almost indispensable. A large proportion of solder consumption is in the automotive and electrical industries. For example, it is not uncommon to have 500 soldered joints in the present-day television set.

The utility of solder for joining metals stems from the fact that the alloys of tin and lead are able to meet a wide range of conditions in jointing and are remarkably easy to work with. The high-tin solders are highly fluid and flow between metal surfaces in close contact and at a relatively low temperature. They find many applications in assembling motors, generators, and automobile radiators. In the latter application, the solder ensures both mechanical strength and conductivity between the copper fins and the water tubes. The lower tin solders (35 Sn) have a long pasty range and are useful as wiping solder for joining lead pipes and electrical cable sheathing, and as automobile body solders.

Great improvements have been made in soldering methods, such as induction heating and electronics[10]. A comprehensive and practical booklet on soft soldering is now available from the Tin Research Institute[11]. This booklet discusses solders, fluxes, soldering methods, and properties of the joints in a practical way. The properties of soft solders and soldered joints have been given considerable attention in a publication of the British Nonferrous Metals Research Association,[12] and recent work on the properties of solders at subzero temperatures appeared in the literature[13, 14].

Bronze

Alloys of tin and copper containing up to 10 or more per cent of tin can be cold worked and wrought in various ways. Bronze rods, tubes, wire, and strip provide a wide range of materials with mechanical properties approaching that of steel with the added quality of incomparably higher resistance to atmospheric and salt-water corrosion. These alloys, sometimes with the addition of zinc and phosphorus, find use in turbine blades, heavy pumping machinery, and similar marine engineering equipment.

Cast bronze up to 28 per cent tin is used for freight car bearings and machinery bearings for rolling mills, looms, crushers, and conveyors. Research conducted in England has improved the methods of casting bronze[15, 16, 17], and several producers are continuously casting bronze in long lengths which simplify the machining operations in automatic lathes[18, 19].

Bearings

About 7 per cent of all tin consumed is used in bearings. One of the important qualities of a bearing lining is its capacity to withstand seizing up on the shaft, which is bound up with its ability to hold a film of lubricant. Tin is pre-eminent in oil-retaining quality, and its softness or low resistance to shearing contributes to its avoidance of galling or seizure. Resistance of tin to corrosion is a factor which cannot be ignored in practice. In this respect, it is better than lead, its nearest competitor.

Double Seaming Ends of Can Bodies.
Courtesy American Can Company

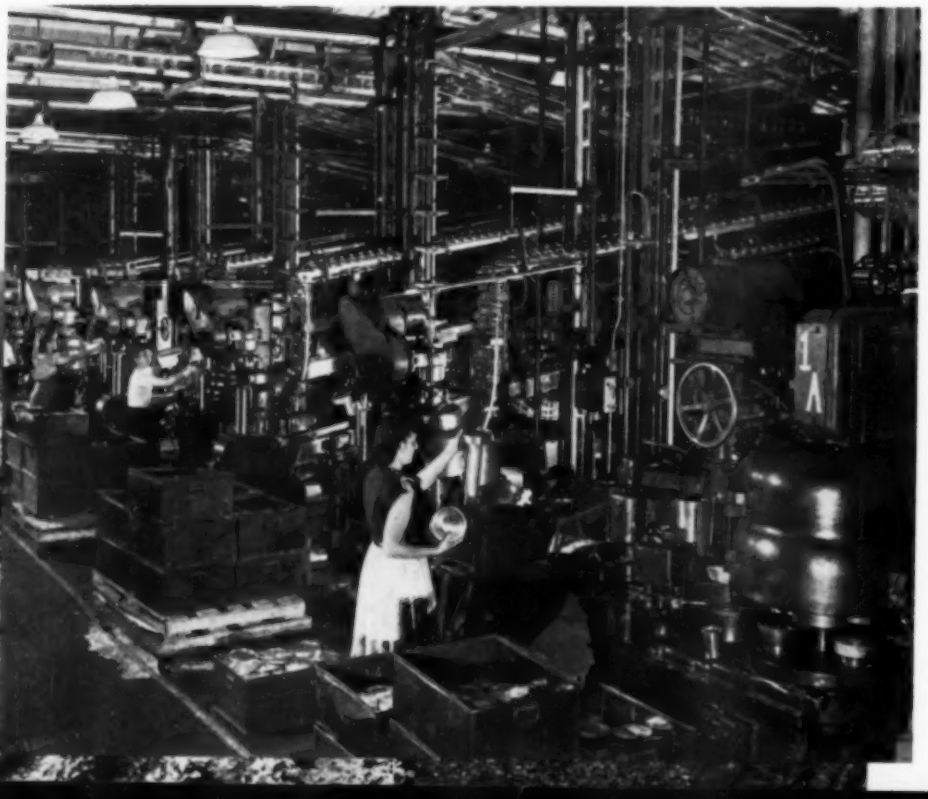

TABLE I. WORLD TIN STATISTICS
(Tin in Concentrates)

	Long Tons	
	1947	1948
World mine production	114,500	152,900
World metal production	124,500	159,600
World metal consumption	136,900	138,900

Tin and its alloys are easy bearing materials to handle in bonding the bearing surfaces to the stronger backing metal or shell.

The low mechanical strength of tin, valuable from one point of view, limits its capacity to carry heavy bearing loads. Under severe pressure, fatigue cracking may occur. For use in automobile and freight car bearings, the tin-rich bearing alloys, the tin-lead alloys, and tin-bronze alloys compete strongly with the copper-lead alloys. New knowledge of the properties and art of manufacturing bearings has been made public by the Tin Research Institute in recent publications[20, 21, 22].

Collapsible Tubes

The collapsible tube possesses certain unique advantages as a packaging medium for pharmaceuticals, pastes, and paints. Its neat, pleasing appearance and its ability to be sealed hermetically with a cap has special appeal to the user.

Although lead and aluminum tubes have gained considerable ground at the expense of tin because of wartime shortages, tin is nontoxic, and the tin tube is admitted to be the best sanitary container. The return of the manufacturers to the tin tube, while dependent partly on economics, is highly desirable because of the simplicity of the extrusion process used in the manufacture of the tube from a soft and self-annealing metal like tin.

Hot Tinning Fabricated Articles

The hot-dip coating of mild steel milk cans is one important application for the heavier tin coating. In this application, the quality of the product depends largely on the preparation of the steel base. A practical manual *Hot Tinning*, which describes up-to-date methods of tinning steel, copper, cast iron, and other metals is available from the Tin Research Institute[23]. Tinned copper vessels find a large number of domestic and industrial uses. Copper is an excellent material for making equipment for pasteurizing or refrigerating large volumes of milk, because of its ease of fabrication and its thermal properties. Without a tin coating, copper could not be used owing to the deleterious effect this metal exerts upon the milk flavor.

Another important application for tin is as a coating for conductor wires for the electrical industry. The tin coating prevents interaction between the copper and the sulphur in the rubber insulation which would lead to its rapid deterioration. The tin also ensures ease of soldering the wires.

Alloy Coatings

A tin-zinc electroplated alloy has been developed in England as a substitute for cadmium plating[24, 25]. The alloy composition is preferably 75 to 80 per cent tin and 20 to 25 per cent zinc. No unusual difficulties in plating have been experienced and the corrosion resistance has proved very satisfactory, solderability is excellent, and the coating is not expensive.

Speculum plating of an alloy containing about 42 per cent tin and 58 per cent copper has been under development for several years[26]. The development has suffered largely from wartime restrictions on the use of tin, and also from the inability to produce a bri t plate. Speculum has a pleasing appearance and freed m from tarnish, and may find increasing use for finishi ig articles employed in the home.

Fusible Alloys

The low-melting fusible alloys containing tin, lead, bismuth, and cadmium find important applications in safety devices, fire alarms, low-temperature solders and seals. The eutectic alloys have been useful in research work on temperature measurements, for mounting specimens, and for electrochemical work. A revised publication on this subject will be available shortly from the Institute.

Research and Development

A continuous program of research has been in existence at the Tin Research Institute laboratories for many years. In cooperation with other research organizations, current problems are concerned with research on tinplate, hot tinning, electrodeposition, bearing metals, chemical compounds, bronze, solders, corrosion research, and fundamental problems. Results of these studies are freely published and made available by the Institute to all who may apply. ●

(Continued on Page 105)

TABLE II. TIN STATISTICS — UNITED STATES

	Long Tons			
	1947		1948	
	Primary	Secondary	Primary	Secondary
Total tin consumed	63,078	24,103	64,064	26,349
Tin consumed in tinplate	31,833	——	32,822	——
Tin consumed in solder	15,152	4,544	16,791	4,960
Tin consumed in babbitt	4,564	2,265	4,268	2,215
Tin consumed in bronze	5,674	15,474	5,143	17,113
Tin consumed in collapsible tubes	1,111	253	814	126
Tin consumed in tinning	2,764	61	2,821	16
Tin consumed in other manufactures	2,100	1,386	1,760	1,560
Tinplate production	3,313,221		3,528,750	

New Light on Better Sight

• By R. I. Bull
COMMERCIAL SALES SUPERVISOR, THE OHIO POWER COMPANY OF CANTON, OHIO

This article describes in detail a useful teaching program on light and sight recently made available by the Better Light Better Sight Bureau to schools in the territory of the Ohio Power Company.

The enthusiastic reception that science teachers have given this new project indicates that they find it a valuable teaching tool. In the opinion of many teachers it might well become a part of elementary science and health studies everywhere.

●

The principles of the "Science of Seeing," when they were expressed several years ago by leading scientists, attracted the nationwide interest of educators. The proper care of the eyes and eyesight, with particular reference to the visual environment, began to assume a place of importance, together with such accepted practices for children as dental hygiene, personal cleanliness, and supervised athletics.

Coincidental with this increase of interest, many teachers requested supplementary material on lighting from lamp bulb manufacturers, fixture manufacturers, the Illuminating Engineering Society, and (perhaps most frequently) from their local electric public utilities. The latter, recognizing in such requests the opportunity for worthwhile community service, were, for the most part, active in attempting to fill these requests. This was generally done by assembling into reference libraries the data from manufacturers and technical societies, devising equipment for demonstration of lighting principles, offering lectures on lighting to schools and civic groups, and making available supplementary text material for classroom use. Most of these services, and sometimes all of them, were provided gratis.

In our own company, for example such a service has been offered local schools since as early as 1935. This program originated as a lecture service, making lighting talks available to civic clubs and schools. Soon it was greatly expanded to include not only spectacular demonstrations of light sources and lighting principles, but also a service making available to schools authoritative text supplements on lighting. In recent years, lightmeters were provided to science teachers for class use and, at their option, for checking by the students of their home lighting conditions. The complete service offered teaching aids for the primary, junior high, and senior high school grade levels.

Some measure of the acceptance which this program enjoyed is indicated by the fact that within the territory served by The Ohio Power Company over 65,000 students in all grades participated during the 1947-1948 school year. Of these, 17,000 used lightmeters for practical experiments in lighting control, both at school and at home.

In 1946, giving recognition to the importance of the subject, the National Education Association produced a manual for instructors entitled *Teaching About Light and Sight*. Based on careful research and authentic sources, this booklet has achieved wide recognition and distribution, and is reputedly one of the most widely used of all NEA publications.

One of the sources consulted during preparation of the manual was the national Better Light Better Sight Bureau, which is "an educational program organized in 1934 under the sponsorship of the electric and allied industries to foster a better understanding of the relationship of light and sight." Shortly after publication of the NEA manual, the Better Light Better Sight Bureau (or as it is commonly known, BLBS) set about to prepare a complete classroom project based on the

FIG. 2—Teacher using the demonstration kit. Chart on blackboard is one of series of 12 forming part of the Bureau's program.

manual. Their purpose was to translate the principles set forth in the NEA booklet into a simple and practical study unit. The most careful consideration was given to selection of age level, choice of vocabulary, continuity of text, and illustrative material. Educational authorities and reliable text books were frequently consulted.

Finally, in 1948, the Bureau produced, for the fifth and sixth grade level, a complete work project entitled "The Story of Light and Sight." Briefly this material consisted of a set of three consecutive lesson sheets and three quiz sheets, packaged in quantity sufficient for a class of 40 students, together with a set of twelve colored wall charts (24" x 36") illustrating good seeing principles, plus a comprehensive guide book for teachers, and finally a copy of NEA's *Teaching About Light and Sight.*

Recognizing the value of this material for our local schools, we obtained samples of the program and submitted them to some of the teachers and supervisors in our territory. We asked for their candid opinions as to possible acceptance by the teaching profession. The response was so favorable that The Ohio Power Company felt justified in substituting the new program for the material previously used in the elementary section of our educational program service. To supplement the printed matter, we prepared a demonstration kit, consisting of charts, a prism, a lightmeter, a small floodlamp, and an extension cord. This kit would facilitate class demonstrations of certain lighting principles, as suggested for the instructor in the "Teachers Guidebook." A portion of this kit is shown in Figure 1.

FIG. 1—Portion of the demonstration kit developed by The Ohio Power Company, showing the Light Meter, 75W R-type floodlamp, 12' cord and plug, prism and lightweight metal case.

In the fall of 1948, we presented to superintendents, supervisors and principals in our schools for their approval the revised Sight-Light Program, as it is known. Their interest was quick, and permission to discuss the program with the teachers was, in most cases, readily granted. The general response, indeed, was so rapid that we were not quite prepared for the volume of requests received for the work project. Despite their already full curricula, approximately 80 per cent of those interviewed wished to use these study units in conjunction with their class instruction.

Fundamentally, the general acceptance of this program was due to these factors:

(1) It is free of advertising or commercialism of any kind.
(2) The continuity and choice of language used in preparing *The Story of Light and Sight* are directed particularly toward a definite age level.
(3) The program is based upon a recognized and accepted teaching aid, the NEA booklet, *Teaching About Light and Sight.*

Administrators have indicated that with so many "projects" being offered to schools today, each must stand squarely upon its own merits as a basis of approval for use in the classroom. One school supervisor, in fact, stated that, of over 100 such projects inspected by his office, only five were sanctioned for use in his school system. Of the five, one was *The Story of Light and Sight.*

With the close of the 1948-1949 school year we asked our field organization to talk to the teachers who had used the Sight-Light Program, requesting their comments and opinions on the material provided. Reports just compiled indicate that we were thoroughly justified in offering *The Story of Light and Sight* as part of our program for schools.

Most teachers stated that they had found the work sheets, presented in conjunction with the demonstration kit, easy to use and readily grasped by the children. Figure 2 shows the manner in which the kit was adapted to classroom presentation. They liked the flexibility of the material which permitted them to cover it in three class periods, or to spend two weeks on the subject, as they chose. As one supervisor stated, "The new material is far superior to anything yet produced. Children understand the material better and teachers find it easier to present."

There were a few differing opinions on the grade level of the program. Some teachers felt that the lessons were either too advanced or not sufficiently advanced for the fifth or sixth grade. All seemed to agree, however, that the desirable features were preponderant and, significantly, all those using the program have requested that it again be made available during 1949-1950.

Statistically, during the last school year 23,990 students in 579 elementary schools served by The Ohio Power Company studied, with the aid of this program, the care of the eyes and the influence of light upon good seeing. We like to think that, as a result of this study, many of these children will enjoy good eyesight through their youth and as adults, for a longer time than they might have otherwise. Comments from teachers seem to indicate that this may be possible:

"Window blinds are adjusted frequently to prevent glare and shadows since studying *The Story of Light and Sight.*"
"*The Story of Light and Sight* has helped many of the pupils seek favorable lighting conditions when reading."
"Through the study of Sight and Light, study habits have been improved."
"We are making as many changes as we can to place our pupils in the right light."

(Continued on Page 120)

Industry Discovers Lithium

● By **John D. Clark, B.Cer.E.,** *(Ohio State University)*
and Ralph G. Verdieck, Ph.D., *(Ohio State University),*
FOOTE MINERAL COMPANY, PHILADELPHIA, PENNSYLVANIA

Lithium is not as well known as it should be. This neglected member of the alkali family is an abundant metal of valuable properties, but its commercial development has been retarded by high cost of production and imperfect knowledge concerning the element and its compounds.

Costs are being reduced and fundamental knowledge concerning the element is increasing rapidly. New, important applications are being discovered.

Here experts in the field tell of lithium's properties, reactions, compounds, and uses.

●

We are living in an age of science which demands that if we are to meet properly the needs of the future we must study now and eventually put to work some of the chemical elements that are abundant in nature but currently not well known. Lithium is one of these. It is time to remove the proverbial bushel from its light and permit this valuable element to find its proper place among our important industrial tools. Since it combines in itself certain useful properties of the members of the alkali and the alkaline earth families a wide variety of applications for it should be found.

Until World War II provided the necessary impetus, industry neglected lithium for two reasons: (1) imperfect knowledge concerning the element and its compounds, and (2) high cost compared to the other members of its chemical family. But now definite progress is being made. Fundamental knowledge concerning the element is being rapidly expanded. At present, costs are low enough to enable both the ceramics and the petroleum industries to use lithium compounds in large quantities; and it is axiomatic in manufacturing circles that increasing volume results in decreasing costs. The cost of production will be reduced still further, for efforts are being intensified to win lithium more cheaply from its ores. Even lithium's marginal applications, which have heretofore received little consideration on account of expense, are now being actively examined. Lithium compounds have already found uses in such diverse industries as plastics, air conditioning, porcelain enamels, welding, grease and lubricants, cosmetics and dyestuffs.

Imagineering

Workers who deal with lithium every day and who are familiar with the element's characteristics have "imagineered" for it certain possible uses that have not yet been developed commercially. The stabilizing characteristics of the hydrated lithium ion in systems involving materials subject to base exchange may well lead to advances in the technology of oil-well muds, ceramic casting slips, and water base paints. Because of their ability to solvate many organic compounds certain lithium chemicals may prove to be useful catalysts in alcoholysis and similar reactions. The dehydrating efficiency of low vapor pressure salt mixtures containing lithium may simplify the design and operation of the compact units used to dry natural gas and for other industrial drying operations. The unique solubility and electrolytic properties of lithium compounds in organic solvents may open new fields in conductive plastics, low temperature electrolytes, and static leakage rubber goods. Concentrated solutions of lithium salts often bind available water so effectively that it is not free to ionize. Such "anhydrous water" solutions may be of value in electrolytic systems. These are only a few of the numerous possibilities for the use of lithium that are being visualized.

Properties

Metallic lithium is a silvery-white metal, harder than sodium or potassium but softer than lead. It is ductile, and can be drawn into wire or rolled into sheet. Its relative hardness, Moh's scale, is 0.60 compared to 0.4 for sodium and 0.5 for potassium. The accompanying table lists a number of it properties.

Its atomic number of three shows that the lithium atom has only three external electrons. If these are removed from an isolated lithium atom in a dilute gas, the energy necessary, i.e., the ionization potential, will be 5.36, 75.27, and 121.84 electron volts for the outermost and the two remaining K electrons respectively. The ease with which the outer electron can be removed, together with the difficulty of removing the second electron, makes lithium univalent and places it in the group of alkali metals.

The first ionization potentials of the alkali metals and also of the metals of Group II are listed for comparison:

FIRST IONIZATION POTENTIALS

Li	5.36	Be	9.28
Na	5.11	Mg	7.61
K	4.32	Sr	5.67
Rb	4.16	Ba	5.19
Cs	3.87	Ra	5.25

The ease of removing an atom's first electron is a measure of its alkalinity or basicity. The table shows that lithium is the least basic of the alkali metals, having a value lying between those of strontium and barium of the alkaline-earth family.

The radius of the lithium atom is 1.56 Angstrom units. When the valence electron has been stripped from the atom, the lithium ion formed has a radius

PROPERTIES OF THE ALKALI METALS

	Lithium	Sodium	Potassium	Rubidium	Caesium	Francium
Specific Gravity at 20° C.	0.534	0.9723	0.859	1.525	1.903	
Atomic Volume	13.1	23.7	45.5	56.0	71.0	
Atomic Radius, Angstroms	1.56	1.86	2.23	2.43	2.62	
Ionic Radius, Angstroms	0.78	0.98	1.33	1.49	1.65	
Atomic Number	3	11	19	37	55	87
Atomic Weight	6.940	22.997	39.096	85.48	132.91	223
Bonding Energy, M-M (Kcal/mol)	27.2	18.4	12.6	—	10.4	
Relative Hardness	0.60	0.4	0.5	0.3	0.2	
Boiling Point, ° C.	1336	877.5	759	696	670	
Melting Point, ° C.	180	97.6	63.5	39	28.5	
Heat of Fusion (cal./g.)	32.81	27.21	14.67	6.144	3.766	
Atomic Heat of Fusion (cal.)	0.941	0.981	0.1728	0.0802	0.0522	
Entropy at 25° C.	7.6	12.2	19.7	—	—	
Sp. Heat at about —223° C.	0.1924	0.1519	0.1280	0.0711	0.0513	
Atomic Heat at about —223° C.	1.35	3.50	5.01	6.05	6.82	

of 0.78 Å, which is the size of the magnesium ion. With such a small ionic radius the charge density upon the lithium ion is high in comparison to the other alkali ions. Its high charge density causes it to have a strong coulombic attraction for negative ions. The result of the attraction is seen in the unusually high heat of formation of lithium oxide when compared to the heats of formation of the other alkali metal oxides. Also, the high charge density leads to the formation of complexes with many groups which do not ordinarily unite with alkali ions, i.e. water, alcohols, etc.

The crystal structure of lithium metal resembles that of the other members of its family. It is a body-centered cube at temperatures ranging from room temperature to liquid air temperature. But if the metal is plastically deformed at —196°C, a new phase, a face-centered cube is formed, accompanied by a series of audible clicks. The calculated density of both phases is 0.534g/cc. The face-centered phase disappears fairly rapidly above —117°C.

Lithium's melting point, 186°C, and its boiling point, 1336°C, are considerably higher than the corresponding values for other alkali metals.

Reaction with Air

On exposure to air lithium metal forms a thin film of nitride. This film prevents reaction with oxygen at room temperature. The metal does not ignite in air until heated to 200°C, and then it burns quietly with an intense white light. Unlike the other members of the alkali family lithium has a greater affinity for nitrogen than for oxygen. In fact, it is the only alkali metal known to unite directly with nitrogen. In this respect it resembles the members of the alkaline-earth family.

Lithium nitride, Li_3N, is of interest because of the double nitride it forms with iron, $Li_3N.FeN$. This compound is probably formed when iron and lithium are used as a catalyst in synthesizing ammonia. Iron and nitrogen alone do not form a nitride, but when mixed with either lithium or lithium nitride the double nitride results. It is readily hydrolyzed, giving black ferric oxide, not the hydroxide.

In its reaction with oxygen lithium again differs from the other members of its family. At high temperatures only the oxide, Li_2O, is formed, accompanied perhaps by mere traces of the peroxide, Li_2O_2. Other alkali metals when heated with oxygen form considerable quantities of peroxides.

Halogen Compounds

In general, the heat of formation of the halides is less than the heat of formation of the corresponding halides of the other alkali metals. This is to be expected from the higher ionization potential of the lithium ion. The heats of formation of the halides increase with the rise in the atomic weight of the metal. Lithium fluoride, however, is exceptional. It has the highest heat of formation of all the alkali halides. This can be explained by considering the size of the fluoride and lithium ions. Both have very small radii and correspondingly high charge densities. The coulombic forces between the ions are strong enough to overcome the greater difficulty of removing the valence electron from the lithium atom.

Of all the alkali metal halides, lithium salts have the greatest tendency to form hydrated compounds. The greater the atomic weight of the combined halogen, the greater the stability of the hydrate. Lithium chloride is the only alkali chloride that evolves heat when dissolved in water. The high heat of solution can be accounted for by the heat of hydration or solvation of the lithium ion. The small lithium ion with its high charge density readily combines with water molecules to form a coordination compound or hydrated ion. The small ion size also makes it possible for lithium to form addition compounds with various alcohols. The heat of solution of lithium chloride in ethyl alcohol is 11.74 calories per mole; in methyl alcohol 10.9 calories per mole. The high solubilities of lithium halides in alcohols and in many other organic solvents serve as a convenient means of separating lithium from the other alkali metals.

The lithium halides, unlike those of sodium and potassium, are very hygroscopic, resembling closely the halides of calcium. Although lithium chloride, bromide and iodide are very soluble in water, the fluoride resembles calcium fluoride in being rather insoluble. At 25°C the solubility of lithium fluoride in water is 0.0522 mole per liter. In general, the melting points of the alkali halides decrease with the increasing atomic weight of the metal. Lithium halides, with the excep-

(Continued on Page 115)

Facts About Furs

• By Donald C. Daugherty
CLEARFIELD FURS, INC., CLEARFIELD, PENNSYLVANIA

Everyone who owns furs or who hopes to own furs will enjoy this brief discussion of the fur industry. Science teachers will find in it useful background information.

Mr. Daugherty explains what makes furs valuable, how they are dressed to preserve them and to bring out their natural beauty, and how they are dyed and made into garments.

●

The whole world takes part in the ever growing industry that was one of the most important enterprises in the early development of America.

Animal skins were the first clothing of our prehistoric ancestors. The women of those far off days cured the skins by drying them, scraping off the flesh with a stone scraper, and working in fat until the skins were soft and pliable. If the skins were small, the women sewed several of them together with bone needles, using the sinews of animals for thread. Many of the bone needles which have been discovered have a hole in the blunt end like the needles of today.

The ancient Egyptians used the skins of wild animals for the adornment of the royal family. Leopard and lion skins were most desired, probably because of the strength and the spirit of the animals. The skins of certain animals were used as covers for the tents and altars where ceremonial services were held. People living in warm climates did not need furs for warmth, but they used them for trimming on garments. The early tribes of Europe and North America used fur for protection against the cold.

CLEARFIELD FURS' EXPERT MINK MATCHER selecting and matching skins.

One of the principal motives for travel and adventure and for the discovery of new lands was to obtain furs and to establish fur trading posts. The development of the United States in its early days was centered around the fur trade. The buffalo that roamed the prairies were killed by the thousands for their hides. The hides were removed and the carcasses left on the ground. Herds were so depleted that today only a small number are left, and these are kept in parks which are protected by the government. Beavers were one of the main fur animals trapped in the early days. The Indians would trade a pile of beaver pelts the height of a gun for the few articles they wanted. The guns in those days were the long barrel type and no doubt were made long for use as measuring sticks for fur trading with the Indians.

Peltries used in our fur industry come from every continent of the world. The United States and Canada furnish beaver, fur seal, hair seal, muskrat, mink, marten, raccoon, fox, otter, skunk, lynx, weasel, hare, rabbit and many others. From South America come chinchilla, nutria, spotted cats, otter, seal, lincoln lamb and ocelots. Australia and New Zealand produce rabbit, hare, Australian opossum, kangaroo, wallaby and wombat. Africa contributes Persian lamb, leopard, monkey, seals and kid. Europe and Asia play an important part by furnishing a varied selection of peltries such as badger, barunduki, lynx cat, ermine, sable, fitch, marten, kolinsky, kid, Persian lamb, marmot, squirrel, Jap mink, China mink, caracul and others.

Furs today are worn for both warmth and style. The manufacturing of fur peltries has been greatly improved, and the supply of peltries is so great and so varied that there are fur coats within the price reach of practically every woman. Fur peltries are now used in dyed or bleached states as well as in natural color, and they are worked into skillfully designed styles that flatter the wearer.

Many steps must be taken before fur peltries reach the wearer. The animals must be trapped or raised on fur farms. Fur farming is a steadily growing business for today's demand for furs is greater than can be supplied by trapping alone. After the pelts reach the raw fur dealer, they must be sorted and graded as to quality, size and color. They are then put into bundles of the various grades and sold periodically at fur auctions. Some manufacturers buy the skins raw, and dress the skins themselves or have them dressed by fur dressers. Others purchase them already dressed.

In assorting and grading, the quality and

A SECTIONAL VIEW of fur dressing plant at Clearfield where skins are fleshed and dressed.

color of the fur and the size of the pelts must be considered. First quality pelts must have good prime leather and fully developed guard hair and fur fiber. The pelts must be taken from the animal when they are "prime," or in the best condition, which is in the middle of winter. The one exception to pelts not being prime in the middle of winter, is the animals that live mostly in water, such as beaver and muskrat. These are prime in the spring since the water is coldest at that time. Pelts that are taken in early fall or later winter and spring are not prime and are not considered first quality. Their worth is naturally less. Size and color are important factors in determining the value of pelts. Two pelts of the same size and quality of fur may be different in color, making them of different worth. Or, two pelts may be the same in quality and color but of different sizes, so they must be valued differently.

Nature provides animals with the kind of covering they need for the climate in which they live. The nervous system of the animal is such that under changes of temperature the growth of fur is controlled so that the animal is protected according to the temperature. Climate, altitude, the covering of the ground, whether wooded or prairie land, soil content, rainfall, dryness of the section of the country, etc., all affect fur peltries; thus their value varies with different countries and with different sections within the same country. In cold climates or high altitudes finer and denser-furred animals will be found than in warm climates or at sea level. Content of the soil and the kind of vegetation also affect the quality of fur pelts, since the color of the skins usually follows the color of the soil. For example, the soil in China and parts of Asia has a yellowish tint and the fur of the wild animals is usually yellowish. This is also true of the people living in those sections.

While primeness of a pelt, and its color and size are factors in valuing fur peltries, supply and demand also enter into the pricing of furs. Dame Fashion and man's ability to manufacture the peltries into stylish garments really set the value of furs.

Since animals differ from each other just as plants differ, they are classified into groups. Their eating habits are mainly the basis for putting them in separate categories. The different groups used in the fur industry are: *the Rodents*, of which there are two types—land and water. The land rodents consist of squirrel, rabbit, hare and chinchilla. The water rodents are nutria, beaver and muskrat. *The Felines* or Cat family are flesh eaters. They have short, powerful limbs and soft pads on their feet which allow them to move quietly. When their claws are not in use, they are drawn back into the foot to keep them sharp. This group consists mainly of leopards, spotted cats, ocelots and lynx. *The Canine group* contains dogs, wolves, and foxes. *The Weasel family*, which is a group of bloodthirsty animals is found all over the world except in Australia. Their pelts are used in great numbers in the fur industry. One characteristic of these animals is that they never travel in pairs and are never seen together except in the mating season. This group consists of mink, otter, kolinsky, sable, marten, weasel, ermine, badger and skunk. *The Bear-Raccoon group* consists of bear, raccoon and ringtail cat. *The Marsupials* carry their young in a pouch on the mother's abdomen, as the young are born in an under-developed state. This group is made up of American opossum, Australian opossum, kangaroo and wallaby. *The Ungalates*, or hoofed animals, consist of sheep, lamb, goat, kid and pony. The Lambs are important in the fur industry, several types being used extensively. These are broadtail, Persian lamb and caracul. *The Sundry group* is made up of fur seal, hair seal, mole and monkey. The fur seal has been an important fur for years. It was worn by our great-grandmothers and is still one of the favored furs.

Skins are dressed to keep them from decay and deterioration, to preserve them with the fur or hair on, to bring out the natural beauty of the fur, to make the skins soft and pliable, and to free the pelts of any bacteria that might cause decay.

A skin must go through several processes before it is ready to be manufactured into fur garments. Skins are first put in salt water to soften them and prevent any bacterial action. After soaking, the skins are fleshed to remove fat or flesh particles that adhere to the under side of the skin. This is done by drawing the skins over a sharp-edged blade fastened to a bench, or over a moving disc that has the edge turned to a right angle. Sometimes a beam is used. The beam is similar to a barrel that has been sawed in two in the middle lengthwise. When a beam is used for fleshing, the skins are placed on the beam, and the fat and a thin layer of skin are removed by a worker who uses a sharp-edged knife, called a fleshing knife.

After fleshing, the skins are washed and put into a solution called pickle or tan. This pickle completely

(Continued on Page 116)

Does Light Weaken with Distance?

● By F. M. Steadman
LOS ANGELES, CALIFORNIA

A worker who has reached his eighty-seventh year and is still concerned in developing scientific theories deserves attention, whether or not readers accept his views as sound.

The writer of this paper, a professional photographer, is the originator of the theories of illumination and light intensity discussed here. He is a member of the American Association of Physics Teachers and of the Optical Society of America, and the author of books on photography.

●

If a small white card is placed in total darkness, or held in the hand on a lighted football field, or hung by a string in a fog bank or a cloud, it will take on the darkness or brightness that fills the space around it. The light, little or abundant, would come from many directions to each exposed particle, — as, if printed, to each letter and mark upon the card.

If now the card is placed a few inches from a candle flame, in an otherwise darkened room, it will receive light only from the glowing particles that make up the flame of the candle. If the card is moved farther and farther away from the flame, it appears to be less and less brightly lighted. As a person goes away from a flame, or a light source moves away from a person, this weakening for distance is noted. Is this weakening with distance an illusion or is it true?

A person who watches the light of an approaching automobile, or that of an airplane as it moves farther and farther away, will notice at least two things: The light appears to remain about equally bright, but becomes larger on approaching and smaller as it recedes in the distance, until it appears so small that it is difficult or impossible to follow it any more. However, we know that the candle flame and the headlight have really remained equally large and equally bright all the time. We can say that lights appear to grow smaller as they recede in the distance and larger as they approach us. This is the well known law of perspective at work, to which all dimensional objects, including light sources, are subject. Again we ask,—does light weaken with distance?

It may be interesting to consider where a candle flame or a headlight would produce its greatest illumination. Obviously one would have to get closer and closer to the light source until one were right in the midst of the candle flame or the headlight filament, where glowing particles of red hot wire surrounded you. If you could slip into such a place, there you would find light coming from all directions. That is, you would have a full sphere of light upon you. In the daytime out of doors we are always surrounded by such a full sphere of light. It is easy to see this sphere of light at work, as it shines on a grain of chalk within any mass light source, from an arc flame to a sun.

But it is impossible to separate a single gas molecule from a flame and examine it at work as a separate, independent *point source* of light.

But what cannot be done physically, the present physics books do theoretically, by ignoring the actual, dimensional light sources, thus causing their spreading figures to start, (there being no dimension left in the light source), from what can only be a geometrical point, which is defined as being without width, length, or depth. This shows light as spreading from *nowhere*.

By ordinary observation we can see the complete sphere of light which surrounds us in the daytime, while the true point source must be visioned mentally only, since as a separate working fact, nature does not produce it. These point sources always work in masses, and these masses have measurable dimension.

Suppose you are out in a level countryside field on a starlight night when there is no moon visible. You would be getting light from the many stars across the visible expanse of the heavens. This would be getting light from half of a sphere, or a hemisphere. We could say that you were in a situation of hemispheric illumination. It would be about similar to being out in the same countryside on a day when uniform clouds cover the sky. Now suppose the clouds disappear and the sun begins to shine. You would immediately sense that the light comes almost entirely from one small part of the sky, which is a small part of the hemisphere. Let us think a little more about this idea of light areas.

The candle flame and the filament of the electric lamp each have measurable width, length and depth. The glowing particles in this space are the sources of the light. In a fluorescent light the particles coating the inside of the tube are made to give out visible light. Thus any light source is but a bundle or mass of particles which for one reason or another are giving off light energy directly or by reflection from some other sources. Let us return to the candle flame as our example.

If a grain of chalk is in the midst of the candle flame, it would be receiving light energy from all directions around it. This we have called a whole sphere of light. Now if you are right on the surface of the candle flame, it would be like being on the surface of the earth on a starlight night. You would be getting light energy from half of a sphere or from a hemisphere. If you move the grain of chalk away from the candle flame, say, one inch, it would be getting light from approximately ⅛ of a hemisphere. If you move it

away about 4 inches, then the area of the flame represents about 1/128 of the hemisphere. As it is taken farther and farther away, the area of the flame occupies less and less of the hemisphere until the distance is so great that the area of the flame becomes a mere point in the hemisphere of space. Let us now turn to the sun as a source of light.

At our distance from the sun we can see that its area represents but a very small part of the hemisphere of the heavens. However, if we were on the planet Jupiter, which is about 5.2 times our distance, then the area of the sun, (or its "extension," as Flammarion terms it) would represent about 1/27 of what it does to us. If we journey to more distant planets we would notice that the area of the sun, in comparison to the hemisphere of the heavens, would become less and less, until, if we could get far off in space, it would look like only a very tiny star. We know that both the candle flame and the sun do not change in their brightness or their real size. They, like a light in an airplane have only appeared to become smaller, and send light to us *from less and less of the hemisphere of directions* as the distance increases. The rest of the light energy is given off in directions which do not reach us.

We can now return to our question: Does the light weaken with distance? Distance alone does not weaken any light. Distance causes the light source to appear smaller and smaller, since it is always becoming a smaller and smaller part of the hemisphere from which we commonly get our light. Thus if you are reading by the light of one electric lamp, and if you move twice as far away from it, you would have to screw in three more bulbs to get the same illumination you had before, because the bulb at twice the distance represents just one-fourth of the space or extension that it represented at the first distance. If you move three times as far away, you will need nine similar bulbs to make the light come from the same number of directions that it did from the first distance, in order to get the same illumination. At ten times the first distance you will need 100 similar bulbs to equal the same part of the hemisphere, and thereby the same brightness as at the first distance. In order to have the same illumination from similar lights at different distances, you must have the light come from the same fractional part of the full hemisphere; which means, simply, *the same number of directions*. This is the hemispheric, solid angle dimension.

The nature of light is such that distance has no effect on the brightness which it produces on other things unless the change in distance has also changed the number of directions from which the light would come to each point, or to each unit of a surface, as to each letter on this page. The light of the stars, coming to us from billions upon billions of miles away, has not been weakened by the distance. The giant telescopes merely increase the size of the space receiving the light energy and then magnify the image in order to make up for the smallness of the stars within the hemisphere of space before us.

Although no single, distant star could make any object visible to our sense of sight, when the lens of the eye and of the telescope cause its light to come to points from more directions, (as to each rod and cone of our retinas and to each grain of the photographic emulsion on which this star is pictured,) the light of that star *persists*, and makes it visible, because the unending waves of light which it never ceases to send out into space *have not been weakened by the distance traveled.*

If we were to follow this truth that light does not weaken with distance, we would teach much less of the point sources of light and deal with the natural light sources which have measurable dimensions. Instead of asking pupils to remember that light varies inversely with the square of the distance, we would teach that illumination varies directly with the hemispheric extension of the light source (as Flammarion deals with the sun, from the different planets). Instead of trying to help pupils to understand the "f" stops in our present cameras, we might help them to re-label those stops in the terms of a simple unit of the hemispheric solid angle dimension, so that they would understand the working of that dimension, both in and out of their cameras, as naturally as they now understand the circle of plane angle and its measurement in degrees. ●

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Tin is a Useful Metal

(Continued from Page 97)

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NEW BOOKS

Out of My Later Years

• *By* ALBERT EINSTEIN. New York: Philosophical Library. 1950. Pp. 282. $4.75.

This is a collection of some 60 essays, articles and addresses, most of which had appeared in print previously.

It is virtually impossible to review this book in the ordinary sense since this would entail 60 sets of comments and would make the review almost as long as the book and, no doubt, less interesting. It is better to describe the subdivisions of all the papers collected between these covers. They fall into the following groups: Convictions and Beliefs, Science, Public Affairs, Science and Life, Personalities, and finally a series of articles on the Jews, under the heading of My People.

This reviewer is best qualified to comment on the purely scientific articles. These are written with the simplicity and clarity that have long been characteristic of the author. It would probably be an exaggeration to say that a layman could understand them easily, but certainly those who have some knowledge of physics and mathematics will find them readable and enlightening. Most of the remaining articles are contemplating or philosophical in content. This reviewer is perhaps not altogether qualified to sit in judgment of their subject matter. He will, therefore, limit himself to just one comment. It seems that Professor Einstein is inclined to treat the human being individually and collectively more or less as a complex of physical laws. While this lends singular clarity to Einstein's opinions, it does occasionally seem to color them with a tint of naivete.

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New Frontiers of Psychology

• *By* NICHOLAS DEVORE. New York: Philosophical Library. Pp. VI + 143. 1949. $3.00.

This little volume by a philosopher-psychologist attempts to reassure our contemporary psychological thinking. The author's quest is the formulation of an intelligible psychic framework that will provide man with a key to the attainment of "happiness." In the opinion of the writer the noble effort has failed.

An imposing array of psychological themes is explored; among them, the spiritual and the physical, the urges and the emotions, instinct and conditional reflex, the sub-conscious, man's dynamic needs, etc. The presentation, however, is neither methodical nor clearly explicated. It is the analysis of an armchair philosopher who has read extensively, but who shows little attention to logic and science. At times the style borders on obscurantism.

The author's concern with a rediscovery of the spiritual may, on first impression, seem commendable, but with more careful reading this impact wanes. Spiritual reality is equated with physical energy, which in turn is identified with physical manifestation. This thesis, if it can be termed such, is not satisfactorily established.

It was the intention of the author to help resolve the age old body-mind controversy. His rejection of psychophysical parallelism is quite sound, but he also repudiates the psycho-physical interactivity concept of the Theo-Thomists. With the introduction of his untenable theory of interaction he has succeeded in adding to the controversy.

The book, however, has some merit, bordering on charm in its latter chapters. Good analysis and reasonably sound advice are given on the psychology of fear and inhibition. The one great virtue of this book is its brevity—something that cannot be said of so much psychological trivia emanating from the press these fitful days.

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College Chemistry in the Laboratory

• *By* LLOYD E. MALM (Professor of Chemistry, University of Utah) and HARPER W. FRANTZ (Professor of Chemistry, Pasadena City College). San Francisco: W. H. Freeman and Company. 1949.

This laboratory book is very similar to "A Laboratory Course for Pauling's General Chemistry" by the same authors. It contains the same excellent drawings illustrating apparatus and techniques, the same looseleaf format, and some of the experiments are the same. The number of experiments has, however, been increased to 46, so that the book now has a sufficient number and variety of experiments to be used with classes in which qualitative analysis is not part of the first-year's work.

Until a book has actually been used with a class in the laboratory it is difficult to evaluate the completeness of the coverage and the adequacy of the instructions. It appears in this case that the coverage is adequate. The titles of the experiments are conventional, even though the actual experimental approach may deviate from that found in many other manuals. Under the experiment titled "Oxidation-Reduction," for example, the student is shown how to set up a partial potential series for oxidizing and reducing agents.

All in all, the book seems to be a great improvement over its predecessor in both adequacy of coverage and in details of instructions for the students.

Tobias H. Dunkelberger

Principles of Chemistry

• *By* JOSEPH H. ROE, Ph.D., St. Louis: C. V. Mosby Company. 1950. Pp. 427. $3.50.

Regardless of what any reviewer may think of it, any textbook that reaches a seventh edition after requiring five printings of the sixth edition, has demonstrated its usefulness in its field. Designed more especially as an introductory text for nurses, this little book is also offered for use in courses of home economics and applied chemistry. It finds its widest use in the very brief courses in chemistry taught in certain training schools for nursing, but it would not be of value in courses of more advanced character. Some idea of the elementary treatment of the material in this book may be gained from the fact that in some 400 pages it deals with inorganic, organic, and physiological chemistry.

A paper-bound consumable laboratory guide by the same author, now in its second edition, lists 52 exercises, more than the average class will complete but enough to permit the instructor to have a choice in selecting experiments. The manual is priced at $2.25.

H. C. M.

General Chemistry Texts

Textbook of Chemistry. EDWARD MACK, JR., ALFRED BENJAMIN GARRETT, JOSEPH FREDERIC HASTINGS, and FRANK HENRY VERHOEK (all of The Ohio State University). viii + 876 pp. Boston: Ginn and Company. 1949. $5.00.

General Chemistry. An Introductory Textbook of General Chemistry. LINUS PAULING (Professor of Chemistry in the California Institute of Technology). x + 705 pp. San Francisco: W. H. Freeman and Company. 1950. $4.50.

College Chemistry. Second Edition. JOHN ARREND TIMM (Professor of Chemistry and Director of the School of Science, Simmons College). xii + 764 pp. New York: McGraw-Hill Book Company. 1950. $4.50.

Whether an elementary text is considered good or poor depends greatly on the point of view and prejudices of the reviewer. Consequently, in an effort to retain some measure of objectivity, these three texts will be intercompared rather than praised or criticized.

All three presume, according to the prefaces, to be up-to-date in the sense that the latest concepts and information are included. This is indeed the case, though the emphasis varies considerably from one to another. The Pauling book is almost belligerently modern; in fact Pauling is one of the most competent and vocal of the growing school of structural chemists. The other two volumes show a considerable dependence on the material in the parent books—the distinguished McPherson-Henderson in the case of the Ohio State text and the first edition in the case of Timm. Of these two, Timm shows the latest complete break with the established concepts and methods; for example, he deals primarily with valence changes rather than electron changes (though these are included) in balancing oxidation-reduction equations, and no mention was found of the Lewis electronic theory of acids and bases. Timm has, however, as frontispiece a beautiful colored photograph of plutonium hydroxide, which is perhaps the most up-to-date touch to be found in any of the books.

The arrangement of each text is a plausible and consistent one, but wide variations appear from one to another. Oxidation-reduction, for example, is found in chapter 12 in Pauling, 14 in Mack, and 37 in Timm. The arrangement in Pauling, in the reviewer's opinion, has been greatly improved over that in his "General Chemistry."

The influence of large numbers of engineering students is evidenced in Mack by a greater attention to the chemical aspects of industrial processes. It is pointed out—and rightly—that chemistry is not only a science but the basis of many industries. The industrial outlook is less prominent in Timm, and least in Pauling. The industrial viewpoint may, perhaps, account for the relatively great emphasis on organic and biological chemistry in Mack: 5 chapters, 110 pages, as compared with 4 chapters, 60 pages in Timm, and 2 chapters, 48 pages in Pauling.

Each book is extensively illustrated with drawings and photographs: 388 in Mack, 202 in Timm, (Pauling not numbered consecutively). It is a pleasure to note that the illustrations have been selected or prepared to illustrate some chemical point and not merely to break up the monotony of solid pages. The carefully prepared diagrams of molecular structures in Pauling, for example, set a trend and an example that will no doubt be widely adopted in future texts. Extensive tables, questions, historical notes, suggestions for additional reading, and other aids to the serious student are included in all three books.

Finally, it is a pleasure to give high praise to the publisher and printer. All three books are outstandingly attractive in format and binding. The Pauling book, it should be noted, appears to be much more sturdily bound than the earlier books by this publisher. In rather extensive reading not a single misprint was detected in any book.

Which is the best text? Each will no doubt have many adoptions and strong supporters. A fine argument—perhaps even a fight—would certainly result if these supporters could be rounded up and asked to decide the question. The reviewer prefers to stand calmly by and let the users decide the matter—because they will anyway.

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Forgotten Religions

• *Edited by* VERGILIUS FERM. New York: Philosophical Library. 1950. Pp. xv + 392. $7.50.

Religious instinct is as old as man. It can be described scientifically from psychological and historical approaches. To satisfy it, man has established through the centuries many religions, each suited to a given civilization's perception of man's relation to the supernatural. Man is psychologically geared not only to adjust himself to immediate surroundings, but also to the requirements of laws superior and external to himself. His attempts to understand such laws and to behave according to their requirements have caused man to establish many religions. While the religions of history differ considerably in their external trappings and in the labels they apply to supernatural powers, they are nearly all remarkably similar in two things. They prove beyond doubt the validity of the naturalness of religious instinct, and that men of all ages have believed in a supernatural Lord and in patterns of human behavior imputed to his wishes.

The beginnings of man's hunger to understand things far beyond all visible horizons lie buried in antiquity's religions. *Forgotten Religions*, a symposium by specialists, not only helps the average person to better understand religious instinct, but also provides solid fare for scholarly minds. It helps mightily in dispelling current confusion concerning man's true nature.

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Elements of Geography, Physical and Cultural

• *By* VERNON C. FINCH and GLENN T. TREWARTHA, New York: McGraw-Hill Book Company. 1949. Pp. x + 711. $6.00.

This successful college textbook has all the excellence and merit one has learned to expect in books with which the names Finch and Trewartha are connected. Well designed, splendidly illustrated, compactly written, this new third edition is an example of good bookmaking. The authors do not believe that geographical science should be primarily concerned with showing how and to what extent the physical features of the earth influence human affairs. They conceive physical geography as a science which treats of the potentialities of the physical earth for the use of nations and peoples. They emphasize the study and conservation of natural resources. The first two chapters orient the student. Then comes a major section dealing with the nature of the elements of geography and upon their world distribution. A second section considers the nature and classification of the significant elements of material culture essential to geography.

H. C. M.

Teaching Biology for Appreciation

• *By* ALFRED F. NIXON, B.S., S.M., Ed.D., Boston: Chapman & Grimes. 1950. Pp. 146. $3.00.

Dr. Nixon believes that emotional appeal as well as information is necessary to help students develop a full appreciation of high school biology. He suggests providing such appeal through the warmth, sentimentality, and emotionalism of art, literature, and the social studies. He makes out a good case for a correlation of such courses with biology, and then demonstrates specific ways in which the linkage can be effected. He shows how biological information used in connection with these non-science courses will deepen student interest, understanding, and appreciation, and also utilize certain native abilities. The author makes many practical suggestions for interrelating the courses, offers a number of photographs showing student projects involving biology and art, and gives a few outlines for teaching units in the social studies area. There are rather extensive bibliographies.

This stimulating book is addressed to teachers of biology, but it contains hints and techniques that can well be adapted for use with the other sciences.

H. C. M.

Textbook of Healthful Living

• *By* HAROLD S. DIEHL, M.A., M.D., Sc.D., New York, N. Y.: McGraw-Hill Book Company, Inc., 1950. Pp. XII + 776. $4.00.

This fourth edition of a popular college textbook has been improved by the expansion of the section on community health for the purpose of showing better to young men and women their responsibilities as citizens in health matters. There is much information concerning personal hygiene, the betterment of health, and the prevention of disease. The book's scientific and medical accuracy will not be questioned since the author is dean of the medical sciences at the University of Minnesota. Catholic readers will, however, take exception to certain statements in the chapters on sex life and parenthood. Educational motion pictures and film strips are available to supplement the material given in some of the chapters. The book is concisely written and gives a wealth of information in tables, charts and graphs.

H. C. M.

Building a Betatron

(Continued from Page 87)

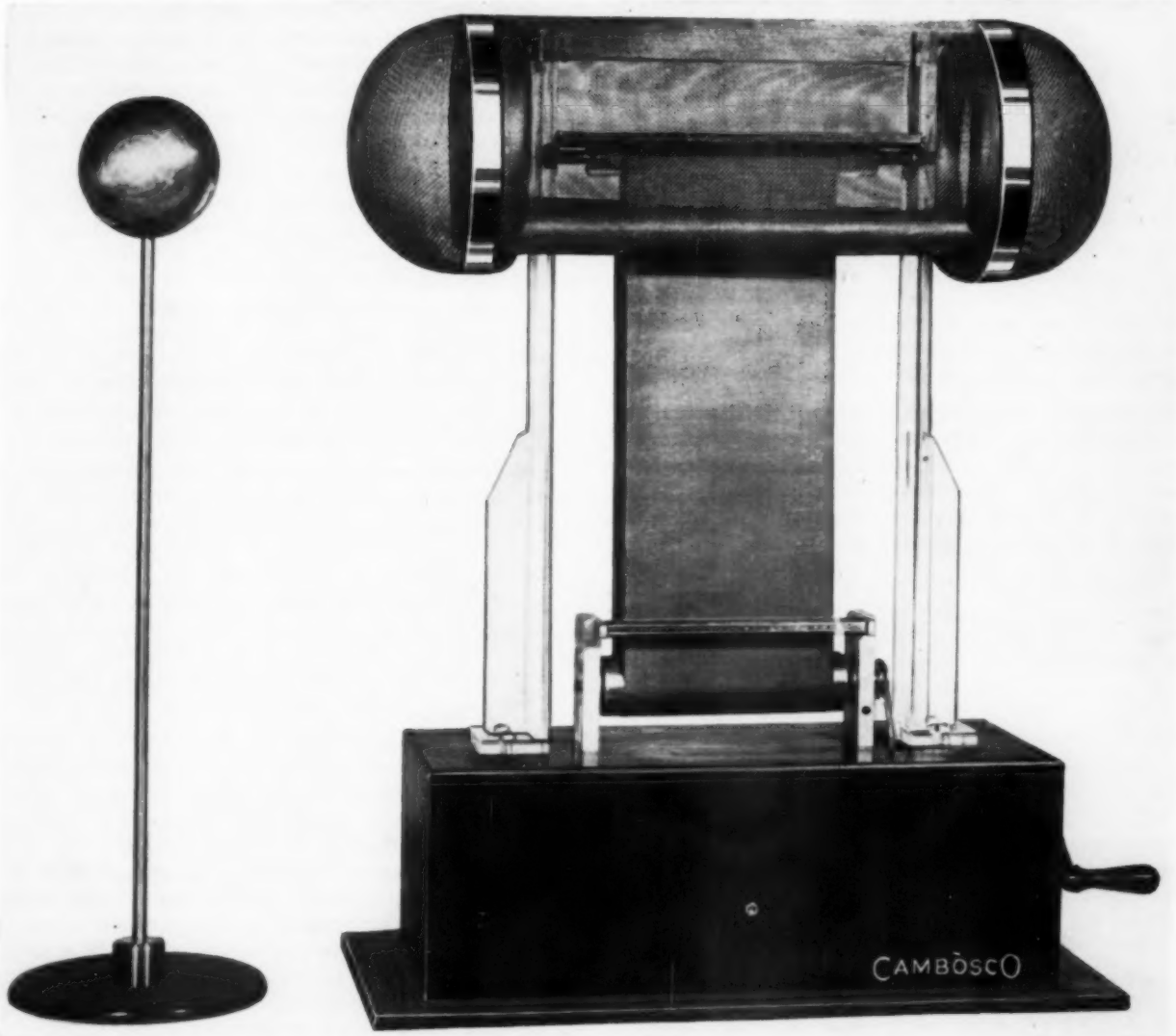
but at nearly market prices. The saving in this case was in time. Commercial suppliers all had a backlog of orders.

The operating voltage of the betatron was chosen as 1320 volts, to conform with the voltage ratings of the condensers. This meant that the current in the exciting coil would be over 300 amperes. Such a current required large size conductors. However, these large conductors could not be solid, or even ordinary twisted wire, because they would be operating within a strong magnetic field. This magnetic field would cause the current to crowd to one side of the conductor, causing high power losses. To prevent this, the conductors had to be made from many strands of individually insulated wires, and these strands had to be twisted, so that the average effect of the magnetic field would be the same on each strand of wire. This work was done in a vacant building on the University campus. Since 150 foot conductors were needed and only 100 feet of space was available, the strands were clamped together at the center and one half of the cable was twisted at one time. The multi-stranded cable was kept small and neat by twisting seven wires at a time, then twisting seven of these small cables, a total of 49 strands, into the final cable, which was ⅞ inch in diameter. This was done with hand operated equipment that was designed and built at the University for this particular job.

In addition to the magnet, coils, and condensers, many pieces of auxiliary equipment were needed. An electronic system and a specially constructed electron gun were needed to inject the electrons into the vacuum tube. Vacuum pumps to pump the tube down to one billionth of atmospheric pressure, and sensitive gages to measure this pressure were required. More electronic equipment had to be constructed to force the electrons from their path so that they would strike the target. Timing of these operations had to be accurate and dependable, as well as easily adjustable. Thus the project expanded, taking in many phases of physics and engineering.

The betatron is a versatile machine. This one was built for making fundamental experiments in nuclear physics. Other betatrons are already doing this type of work. Betatrons are being used in medical therapy, particularly in the treatment of cancer. Their high energy X-rays and electrons penetrate much deeper than the rays from conventional machines. Radiography is another field in which the betatron has found an important place. Solid pieces of steel ten inches or more in thickness can be X-rayed easily. Smaller objects can be X-rayed so quickly with these powerful rays that an X-ray inspection can be made a part of an assembly line. These and other applications of a betatron insure this machine a permanent place as a scientific instrument and an industrial tool. ●

FIRSTURN ELECTROSTATIC GENERATOR
Delivers 200,000 Volt Discharge



● At the *first turn* of the crank, this new Electrostatic Generator delivers a crashing spark . . . whether the day is dry or humid! On that basis alone, it will be welcomed by every physics lecturer who has ever apologized for the temperamental performance of an old fashioned "static machine."

● Like its larger counterparts, to which Nuclear Physics owes so much, the Firsturn Generator consists, essentially, of an endless, charge-conveying belt, which is here reduced to its simplest, most comprehensible terms.

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Vitamins by the Ton

(Continued from Page 84)

who make sure that Vitamin D is in the infant feeding formula to prevent rickets, often prescribe other vitamins for babies and for growing children. People not in perfect health cannot eat everything they want, or need, or are served, and certain diseases increase the amounts of vitamins the body requires.

One of the most salutary and interesting applications of vitamin therapy is the use of vitamin K to prevent hemorrhage in the new born baby, which can be accomplished either by giving the mother an injection during labor, or the baby one immediately after birth. In some instances both measures are taken. B_{12} is promising an increasing number of applications in the hands of the physician. Clinical research is checking reported effectiveness of vitamin B_6 (pyridoxine) in nausea of pregnancy and radiation sickness. Widespread experimental use of vitamin E continues.

Therapeutic use by physicians in treating these known conditions, and in clinical experimentation along a never ending series of new avenues, involves dosages naturally much higher than the minute amounts of vitamins thought of in connection with foods. And so this bulk vitamin market is really huge.

Now let's take a look at the manufacturing of bulk vitamins. Visitors at Roche Park sometimes are surprised to find out it is something quite different from the theoretically simple extraction from a food source. And when they hear the term "synthetic" they ask if a synthetic vitamin is different from a natural one. They unconsciously are recalling differences between natural and synthetic rubber, or an association of several decades ago between "synthetic," "ersatz" and "imitation." The term "synthetic vitamin" is really a misnomer unless the adjective "synthetic" is understood to describe the method by which the vitamin was manufactured. For a vitamin itself is a chemical entity, having definite identifying chemical structure and characteristics.

Vitamin C, for instance, is ascorbic acid, its composition is $C_6H_8O_6$, its crystals have a definite shape, and it has a specific melting point. Similarly, vitamin B_2 is riboflavin whether you extract it from milk or tea leaves, or produce it by fermentation or by straight chemical synthesis. This question has been disposed of repeatedly and amply.

Depending upon selling price, it may be economically possible to take your vitamin from some natural source, as has been the case of vitamin A from fish liver oils. Some of the early quantities of pure vitamin C offered commercially were from paprika. The efficiency of these methods, however, is usually limited so that even with high yields they are not able to compete with the refinements that develop in large scale commercial synthesis. For instance, in the large quantities in which vitamin B_1 is sold to food and pharmaceutical manufacturers, a gram which in 1940 commanded a price of $1.40, today is quoted at 16 cents.

This is better understood by remembering that a food which is said to be rich in a vitamin may actually contain it in the proportion of say one part per one hundred thousand. If your process for getting the vitamin B_1 out of raw peanuts was 100 per cent efficient you would have to handle 100 tons of peanuts to get 1 kilo of vitamin. To get a kilo of vitamin C you might have to process 30,000 oranges, and your manufacturing periods would be limited to the crop seasons. You can also figure how you would come out costwise by considering that your manufacturer customers now pay in the neighborhood of $25 for that kilo made synthetically!

How is it all done, this commercial scale production of pure vitamins by synthetic methods? Again using vitamin C as an example, because it probably involves the fewest number of steps of any current vitamin synthesis, the manufacturing laboratories start with ordinary corn sugar. This is reduced by catalytic hydrogenation to sorbitol. The latter is then converted to sorbose by a fermentation process. The sorbose in turn, though several intermediate steps involving other compounds, eventually yields ascorbic acid.

Technical men as well as laymen are astonished at the size and extent of the equipment used in commercial synthesis. At Roche Park, where large percentages of the nation's total production are turned out, the vitamin C installation fills a building which would cover an entire large city block and is six stories high. The mechanical equipment, pumps, condensers, stills and centrifuges, and the elaborateness of piping never cease to amaze even those of us who are accustomed to seeing them every day.

Undoubtedly crowning everything previous, is the new installation for manufacture of synthetic vitamin A. The main building, again of city block size, is of ultra-modern interior design, with mezzanine floors laid around a great center rectangular space so as to provide ready accessibility to parts of the equipment which are several stories high, and to make for easy transportation of materials into and through processing. The synthesis consists of twelve steps. The starting raw material is citral, principal present source of which is lemon grass imported from India and several other parts of the globe. If you are an organic chemist, the accompanying cut will indicate the development of the formula. The process involves condensation, isomerization, glycidation, hydrogenation, a Grignard reaction, esterification, selective hydrogenation, molecular rearrangement, dehydration and other basic chemical procedures. In somewhat less technical terminology the synthesis takes a C_{10} compound (citral) and builds it up to a C_{20} structure.

No discussion of vitamins, particularly one dealing with manufacture and control, would be complete without mention of the almost incredible array of apparatus and delicate instruments in constant use to insure a uniform and precisely standardized product. Each manufacturing unit has its own laboratory which never relaxes its watchful eye over the processes going on. The finished products must undergo no end of testing.

There are chemical tests, physicochemical tests, microbiological tests, and laboratory animals must check the results by these newer and quicker methods for the units in which potency is expressed are based upon biological activity. Production batches are compared with standard reference materials distributed by the U.S. Pharmacopoeial Revision Committee. Each production batch must also meet a long list of rigid specifications placing limits upon such factors as moisture content, ash, metals, optical rotation, color of material, solubility, color of solutions and, in the case of solids, range of particle size.

These multiple details of manufacturing and control are multiplied by the need for offering some of the vitamins in more than one commercial form. Vitamin C, for instance, is marketed as a fine powder and in several granular types, plus still another so-called "ampul" type for the pharmaceutical manufacturer making injectable solutions for physicians. Vitamin B_1 is offered in two types, regular and ampul. Vitamin A is offered as a palmitate and as an acetate.

Distribution of the bulk vitamins involves an array of different containers varying from fibre drums lined with pliofilm or polyethylene bags to glass bottles and aluminum bottles. Proper packaging is an important point since single shipments may involve values of many thousands of dollars.

Warehousing is also an important subject. For protection of the trade the bulk vitamin manufacturer is duty bound to carry sizeable inventories so that continuity of supplies is kept up irrespective of plant breakdowns, shipping tie-ups or other difficulties. Each type of each vitamin must be available for immediate shipment in a variety of standard container sizes. At Roche Park there is one entire and separate building for bulk warehousing, specially designed to keep each vitamin separate from the others, and allowing control of temperature and moisture within fixed limits.

Manufacture of these vitamins by the ton is a relatively new industry, but it is here to stay. With our own growing population, and the outlook for increased export markets, total output will increase rather than decrease. The industry is vital to national health, indeed its size today is to a great degree the result of the huge demand for military, civilian defense and foreign relief needs during World War II, during which supplies were controlled and allocated by the War Production Board. A ton of vitamin B_1 represents the adequate daily requirement of our physically active adult population for only two weeks. And if the foods which are our principal sources of vitamin C should have to be withheld from all our civilian population for military or other reasons, synthetic production would have to be stepped up to 12 tons daily! ●

★ ★ ★ ★ ★

"The teacher in the school is in the business of assisting children to acquire behavior patterns which will assure optimum adaptation to the environments in which they live."

Standardization of Material

(Continued from Page 82)

Here is a plan that may be practical in solving this problem.

Let us divide scientific illustrations into two categories: *basic* and *controversial.*

1 — *Basic* illustrations are those which portray accepted scientific facts upon which the study and teaching of science rest, facts with which there is no quarrel, and which are designed to lead the student easily along the approaches to his mastery of the subject.

2 — *Controversial* or conjectural illustrations are those which portray the concepts of groups or individuals, views not generally held by the entire profession, or which portray hypotheses upon which the author proposes to elaborate, and in this category we must include such drawings as anomalies and other personal observations of writers.

With the demands of the second category, unforeseeable, we need not concern ourselves, but we are definitely concerned with the basic group, for this is the type of illustration every writer needs and which is constantly recurring in modified forms. These are the illustrations that can, and should be standardized. Into endless engraving and re-engraving of these drawings and their manifold modifications is constantly being poured an inordinate share of the total of efforts and money involved in producing modern scientific textbooks.

If all writers on embryology, let us say, in the past ten years, could have pooled their resources, an individual outlay of a fraction of their total expenditures would have served them all, and, more, the finished drawings could have been more artistically prepared.

This preparation would have been reflected in lowered engraving costs to the publisher which again would result in a better return to the author.

Would there be a deadly monotony in finding the identical illustration in textbooks "A", "B", and "C" respectively? Not to me, particularly if it were well drawn, if it meant that the controversial drawings would be more carefully worked out.

I am thinking of one illustration that appears almost identically in three current texts, in two instances credited after "so and so" and in the third unnoted. It is an essential illustration and should be employed in any effort to teach important relationships, and to the student seeing it for the first time there can be no monotony. It is only the widely read teacher or the copyright authority who may feel any irritation about the incident.

But here is the plan:

A non-profit **Foundation For Scientific Visual Teaching Material** would be set up under the supervision of, preferably, The American Association for the Advancement of Science, which organization would select panels from each member group for the selection of

those basic illustrations necessary to the proper teaching of each science.

Under the direction of a competent director, a staff of trained artists would in some cases revise, in others completely remake existing pictures of the basic variety, working as much as possible from new preparations.

Further, entirely new figures would be planned eventually to replace obsolescent material.

The Foundation would hold sole ownership of all rights to the use of all material thus produced.

The Foundation would grant upon application, to any accredited scientific writer, the use of such material, such use to be covered by a fee sufficient to cover the costs of making electrotypes, plus a nominal fee aimed at making some small return to the Foundation, such accumulated fees to be used to help defray the expenses of the Foundation. In every case these rights and uses would be limited to one-time publication.

The Foundation would maintain this material suitably filed, to insure its accessibility and preservation for the future.

The Foundation would further function as a means for producing new drawings of the controversial or conjectural variety on a cost-plus basis, assuring the originator of such material of due recognition of authorship by hyphenating the originator's name with that of the Foundation in the credit-line whenever published, always retaining for the Foundation sole ownership of all copyrights.

The Foundation would be administered by the American Association for the Advancement of Science, through appointed or elected representatives.

Among other advantages such a Foundation would:

a) make available to science writers everywhere the services of trained scientific artists,

b) adjust the problems of illustration with those of reproduction and free the author of the task of coordination with the editor on matters of illustration,

c) offer supervised training in illustration to science graduates with a fair promise of satisfactory employment in this field.

It is realized that there may be serious legal obstacles to be overcome, not to mention the considerable thought and planning required properly to put it into operation, but it is not too much to hope that means may be found to launch such an enterprise at a near date, for the question of properly prepared illustrations is a most imperative one.

My chief hope in presenting this somewhat Utopian plan is that it may stimulate a little thought on possible solutions, and not to be the author of the plan itself, for I am aware that the ultimate form of such an enterprise may in no way bear resemblance to this rough draft. ●

The Nutritional Approach

(Continued from Page 89)

category of heavy metals, were fed to Bangs reactors, which thereupon became negative in the cases observed. Iodine was included in the feed supplements because northern Ohio is in the goiter belt. Subsequent developments showed that humans who had undulant fever also responded to the same therapeutic treatment. To date, positive results have been secured in the Ozarks on well over two thousand human brucellosis cases, and on the dairy herds of over one thousand farms. These have been described in various articles by the author and others in a number of trade journals over the past three years.

The remedy in all cases is a feed or food supplement of manganese, copper, cobalt, and zinc in doses designed to adjust the difference between the quantities of these trace elements in healthy cows, as compared with the quantities in cows that have Bangs disease and mastitis. In other words wherever Bangs disease and mastitis prevail, it may be assumed that not only the animal and human body, but also their feed and food supply is deficient in these elements. A supplement to the feed and food is therefore a daily requirement. The necessary dosage for the average cow weighing one thousand pounds is one ounce daily of a trace element mixture that consists substantially of the following:—

2 0 parts manganese sulphate 65% feed grade
20 parts copper sulphate, anhydrous
5 parts cobalt sulphate, anhydrous
3 parts zinc sulphate, anhydrous

Potassium iodide or other suitable forms of iodine at the rate of one and one half grains of potassium iodide should also be furnished, but separately, as it is not compatible with copper sulphate. Iron and magnesium, although never found deficient by the Cleveland investigators ten years ago, may to good advantage be included in the above. They appear immaterial to the diseases in question, so that the dosages likewise are immaterial. They may equal the amount of manganese, double or half it, but of course if equalled or doubled, the total dose of the combination should be commensurately doubled or trebled too.

For humans the dosage was published in the *Merck Report* for July, 1949, in an article "Brucella Infection" by Ira Allison, M.D., F. M. Pottenger, Jr. M.D., and Wm. A. Albrecht, Ph.D., whose book of the same title will soon appear in print.

This story would be incomplete without another reference to phagocytosis and lysis mentioned earlier. The brucella organism, which is the immediate manifestation of brucellosis, has been seen under the electron microscope, which magnifies objects up to 100,000 times. The bacterium was found to be enveloped by a membranous capsule, that is, it was protected by a shell, similar to the way a turtle is protected. In some other diseases such as pneumonia, the organism also has a capsule and in treating this disease, an antitoxin or immune serum prepared by injecting animals with the particular type of germ involved, can be given the patient. This gives only a temporary immunity that

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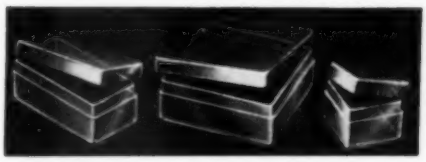

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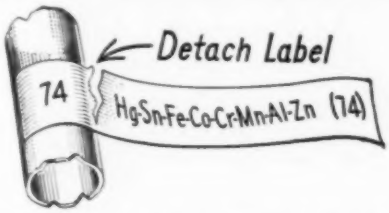

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enables the blood of the patient to destroy or cause lysis of the capsule and thus permit the white cells to remove or carry away the rest of the germ. This method is no longer used since the antibiotics are more convenient and practical. Immune serum has not been found suitable for brucellosis. None of the many undulant fever patients of Dr. Ira Allison obtained any but quite temporary relief from vaccination.

In regard to cattle, many doubtful claims are now advanced for the use of antigen, a suspension of modified or special strains of live brucella organisms, in the treatment of this disease. In this connection it should be strongly emphasized that the injection of live or dead organisms into the animal will not usually develop the large amount of antibodies anticipated, nor stimulate the natural defense mechanisms of the animal to the extent needed to destroy the germs and eliminate them from the body, unless there is already present in the blood of the animal a plentiful supply of the natural globulin essential for this purpose. If the nutritional requirements of the animal in terms of inorganic essential elements, proteins, and vitamins have been well satisfied, the globulin naturally present in the blood will normally be sufficient to ward off an infection. It has been repeatedly shown that animals with poor nutrition develop much less antibody when germs are injected than is the case in similar animals with good nutrition.

The brucella germ has relatively good power to invade poorly nourished body tissues but it also produces a low grade of chronic infection that rarely causes death. It is this combination of good invasive power and low virulence that creates a situation where the disease is widespread, chronic and rarely fatal. The same may be found to be true of widespread mastitis infections. In this case the streptococcus germ usually involved has low invasiveness but the relatively small amount of trauma induced by the continuous daily milking process eventually permits the germ to invade poorly nourished udder tissues. Limited experimental work has already shown that a few herds with extensive mastitis infection have greatly improved when a good trace element supplement and protein supplement is used.

At present, no one knows fully what actually happens when trace elements are used, but the best explanations so far have been advanced by two eminent authorities identified with this subject, F. M. Pottenger, Jr. M.D., Monrovia, California, and Wm. A. Albrecht, Ph.D., University of Missouri, who believe these metals function as coenzymes in the formation of proteins or other body colloids, which inhibit the growth and propagation of the various types of brucella organisms. Since the blood of Bangs reactors and of mastitis cows was found low in manganese, copper, cobalt, zinc, in rather definite proportions, and since

the blood possesses well known bactericidal properties, it may be assumed that the composition of blood protein is an index to either the resistance, or the susceptibility of all warm blooded animals to brucellosis and mastitis.

To those who may disagree with the ideas expressed here, it may prove enlightening to make the tests necessary to ascertain the blood protein composition of healthy animals in comparison with the blood protein composition of diseased animals, and check with the findings of Dr. I. Levis as published in the *History of Randleigh Farm* fourth edition, William R. Kenan, Jr., Lockport, N. Y. 1942. ●

★ ★ ★ ★ ★

How Did Life Originate?

(Continued from Page 92)

> "At the present day, moreover, there is an overwhelming argument in favor of Pasteur's views, and that is the fact that the whole of the vast bottling and canning trades depend upon its validity."

Very few scientists have disputed the work of Pasteur, but it might be well to mention a few of the modern adherents of the theory of spontaneous generation. Bastian is the most prominent of these modern exponents of abiogenesis. He claimed to have made various experiments which proved that life generated from saline solutions in hermetically sealed flasks. His work however, was rejected by other scientists and by the Royal Society of London. It is interesting to note that when any of Bastian's flasks failed to reveal life, he blamed the failure on the media. Herrera is another modern exponent of the theory of spontaneous generation, but he is not so convinced as is Bastian in his views. He combined various chemicals and observed organisms which he called culpoids and sulphobes. He grants that his theory lacks confirmation but claims laboratory corroboration up to a certain point.

As we can see from the work of Redi, Spallanzani, and Pasteur, the theory of spontaneous generation has been disproved as far as is possible. Windle points out in *The Church and Science*:

> "Spontaneous generation *may* take place and may even be going on all around us without our knowing it; but, if so, it *is* without our knowing it, for there is not a single particle of scientific evidence in favor of such an occurrence."

Since spontaneous generation has been relegated to the past as a tenable belief, new theories have arisen to explain the origin of life; the most prominent of these theories concerns the virus.

As yet, there is no proof as to whether the virus is living or non-living. It has only one of the characteristics of a living being, that of reproduction. It does not even contain all the essentials necessary to carry on metabolism. The fact that viruses can be made to crystallize, which is a property of inorganic matter, makes them seem to be non-living. Not even this fact, however, according to W. C. Price, is "sufficient evidence on which to decide whether it (the virus) is animate or inanimate in nature." The approximate size of the virus, as determined by ultrafiltration methods, seems to indicate that it is non-living. It is smaller than some of the smallest bacteria and only a little larger than some of the protein molecules. Nevertheless, the fact that some microorganisms exist which are of a size between bacteria and viruses (Bacillus pneumosintes) is a point in favor of the argument that viruses are living organisms. To date, however, the evidence is inconclusive.

Even if the virus were proved to be living, it is incredible that it should be the first organism. Viruses have attacked almost every commercially important plant except flax; they have caused many diseases in animals; and they have even attacked bacteria and insects. Are we to believe that an organism which can cause disease or death to practically every other type of organism in existence can possibly be the first substance — the link between non-life and the very life it harms or destroys? This would be the paradox *par excellence*. Furthermore, viruses cannot multiply except in living cells. They are highly parasitic and "develop only intracellularly and only in cells that are living and carrying on metabolic activities." Jorgen Birkeland states:

> "If viruses are microorganisms, they cannot represent the most primitive forms even though they do lack the degree of morphologic organization found in bacteria; and the fact that they are parasitic on higher forms rules out the probability that they represent the connecting link between living and non-living forms from the evolution standpoint."

We see now that we are no further in our solution of the question, how did life originate, than we were when we started. The theory that life came from another planet begs the question; the belief that was held for so many centuries, abiogenesis, has been discredited; and the newer beliefs concerning the evolution of the living from the non-living via the virus lack sufficient proof. If it is ever proved that organic matter evolved from inorganic matter, there will be no difficulty in the realm of theology because God could have implanted in non-living matter the power to evolve into living matter. If He did this, it is all the more to His glory. As the facts stand now in science, however, there is still no answer to the question: How did life originate? ●

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★ ★ ★ ★ ★

Industry Discovers Lithium

(Continued from Page 101)

tion of the fluoride, have the lowest melting points of each halide series. In solution lithium chloride resembles magnesium chloride. In aqueous solution it is hydrolyzed more than sodium chloride. During the evaporation of an aqueous solution of LiCl, some hydrochloric acid is lost, and a mixture of the hydroxide and chloride remains. Because of the high solubilities of the lithium halides and the ability of the lithium ion to take up water molecules, the concentrated solutions of the lithium halides should posess properties common to anhydrous solvents or baths.

Lithium halide brines are used as dehumidifiers in air conditioning systems. Lithium metal is prepared by the electrolysis of its fused chloride. Lithium chloride serves as an oxide scavenger and metal cleaner in aluminum welding and brazing fluxes. Both the chloride and the bromide make excellent electrolytes in batteries. Lithium fluoride is an insoluble, active flux in many low temperature ceramic applications including porcelain enamels, glazes, and certain glasses. Welding and soldering fluxes containing this compound became popular during World War II. Not long ago it was discovered that finely powdered lithium fluoride when present even in extremely small amounts prevents an explosion of a mixture of methane and air.

Lithium Carbonate

Lithium carbonate is used as the basic salt for the manufacture of most lithium salts. By reaction with the proper acid almost any lithium salt can be made in the laboratory. Lithium carbonate is used in medicine and in the manufacture of ceramic glazes and glass. Its solubility in water is low compared to the other alkali carbonates, resembling that of calcium carbonate. It is less soluble in hot water than in cold. The addition of potassium sulfate or sodium chloride or

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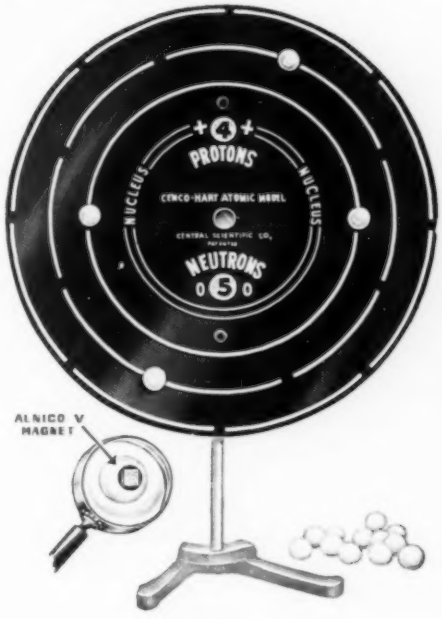

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other salts increases its solubility. Presumably the following reaction takes place:

$$Li_2CO_3 + K_2SO_4 \longrightarrow K_2CO_3 + Li_2SO_4$$

The addition of ammonium salts produces an even greater increase in the solubility of lithium carbonate because the lithium ion forms complexes with the ammonium ion. Although sodium and potassium bicarbonates are quite stable compounds, lithium bicarbonate has never been isolated. It is formed in solution when carbon dioxide under pressure is dissolved in a solution of lithium carbonate. When heated, lithium carbonate is less stable than the corresponding sodium or potassium compound, but it is more stable than calcium carbonate. A decomposition pressure of one atmosphere of CO_2 is attained at approximately the following temperatures: Li_2CO_3, 1270°C; $CaCO_3$, 817°C; $MgCO_3$, 230°C.

Unlike the other alkali metal carbonates lithium carbonate cannot be reduced to the metal by carbon. Instead, the carbide Li_2C_2, is formed. Lithium carbonate is an efficient esterification catalyst in the production of alkyd resins which are base-free. It contributes to a high index of refraction when used as a flux in glass manufacture. Lithium carbonate may be used as a flavor preserving agent in ground coffee. Treated coffee packed in oiled paper immediately after grinding retains a satisfactory flavor and freshness for a year or more.

Miscellaneous Reactions

At high temperatures hydrogen combines directly with lithium to form the salt-like lithium hydride, LiH. It is the most stable of the alkali metal hydrides. It can be melted without decomposition; sodium hydride cannot. The salt-like properties of LiH are pronounced enough to give metallic lithium at the cathode when molten LiH is electrolyzed. Lithium hydride reacts with water to form lithium aluminum hydride, $LiAlH_4$, which is used as a reducing agent in the synthesis of organic compounds.

When heated, lithium will combine directly with carbon dioxide, water vapor, ethylene, and sulfur or arsenic in the vapor states. Its ability to combine with gases makes lithium useful in purifying inert gases such as helium and argon.

Like the other alkali metals lithium reacts with ammonia in the following way:

$$2\,Li + 2NH_3 \longrightarrow 2LiNH_2 + H_2$$

At high temperatures Li_3N attacks iron, nickel, copper, platinum, porcelain and other silicates. At 870°C it will penetrate through any known containing vessel. When heated in a magnesia vessel it leaks through the walls as through a filter.

It has been possible in this short paper to suggest only a few of the potential uses of lithium compounds. There are many others. Forecasting is a risky business, but we venture to predict that in the future lithium and its compounds will become as well known and as widely used as are the other members of the alkali family today. ●

Facts About Furs

(Continued from Page 103)

covers the fibers of the skin to prevent the entrance of destructive bacteria. The skins are then stretched and dried. Oil is put on the skins to protect them from moisture, to keep them soft and pliable, and to lubricate them. The kind of oil employed depends on how the skins are to be used later, whether natural or dyed. The skins are then put in a kicker, which is a machine that agitates the skins to open the fibers and to allow the oil to penetrate. Thin or weak skins are stretched over a dull blade and the oil applied by hand. The skins are partly dried and then put in a drum with sawdust to remove any grease or dust that may be in the fur. They are now stretched and buffed, and then run again in drums with sawdust as the final process of cleaning and softening the skins.

There are several types of peltries such as Alaska Seal and beaver that cannot be used for fur garments in their natural state, but must have the guard hairs removed. This process is called plucking. The fur fiber is also sheared to make it an even height. Some muskrat skins are also treated in this manner when they are to be used in making Hudson Seal coats. These processes are applied during the dressing of the pelts.

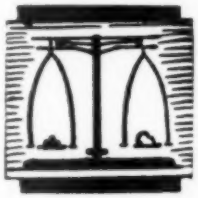
Peltries that do not have an even color, but have prime quality fur, are dyed or blended to make the color uniform. In dyeing peltries the fur or hair must be taken into consideration, and also the condition of the leather, as some types will not withstand the chemicals and the processes of dyeing.

There are several methods of using dye, such as dipping, blending, tipping and shading. Some types are dipped in vats of dye and others are blended, depending upon the skins and the ultimate use of the peltry. Sometimes when it is desired to add beauty to the fur, just the ends of the fur fiber and guard hair are tipped with dye. This process is called tipping. When a very light touch of dye is needed only on the tips of the fur, the dye is put on with the wing feather of a turkey. This process is called feathering. On muskrats both blending and stripping are used. At present, blended muskrat is one of the currently favored furs in the moderate price range.

The manufacturing of a fur coat entails a number of operations. First, the skins are wet on the leather side and permitted to lay for a few hours. Next, they go to the cutter who removes any damage that may be in the skins, and cuts them into various shapes depending upon the type of peltry and the style of coat to be produced. After the pattern for the style and the size of the coat has been selected, he cuts sufficient skins to fit it. The cut skins go to an operator who sews them together to make the various parts of the coat, such as the body, sleeves, collar and lapels. This is done on a machine designed especially for sewing furs. The component parts of the coat are then passed on to the nailer who wets them and nails them on a platform of boards to dry. After the nails are removed, each piece of the pattern is laid on the matching part of the coat

and the edges of each part are trimmed or squared to the outline of the pattern. The squared parts of the coat go back to the operator who closes the coat, which means sewing all parts together to form the coat. The coat is then placed in a drum and drummed for a period of time to make the leather soft and pliable. A few furs, such as Persian and Caraculs, are not drummed because of the character of the curls in the fur. After drumming, the coat goes to the finishers who turn and tape the edges, line the coat and put on the fasteners, such as buttons and loops or hooks and eyes. The final operation is glazing, which is accomplished with varying amounts of moisture and heat. Some furs like beaver, otter and Alaska Seal get an additional heat treatment called electrifying, which brings out brilliant luster.

Interested persons should visit a fur manufacturing plant. Many of the techniques described in the foregoing article will then be more readily understood and appreciated. ●



"Perhaps our institutions of learning have undertaken to do too much and have accomplished the undesired purpose of doing nothing well. Colleges have tried to produce scholars, specialists and researchers, responsible citizens, aesthetes, athletes, technicians, leaders, followers, independent thinkers, solid characters, believers in the democratic spirit, proponents of humanistic values, good Christians and hosts of other products which, in themselves, may be desirable but which due to the manner of their production, may lead to the loss of college integrity because of the multitude of mutually exclusive ends. Colleges may fall victim to what C. A. Holbrook has called their belief in their own 'omnicompetence.'"

—MOST REVEREND WILLIAM T. MULLOY
Steubenville, Ohio

★ ★ ★ ★ ★

"Research shows that children who have had considerable contact with drill which grew out of their own needs, i. e., was meaningful, will acquire a principle very important on upper levels, namely, that drill or practice is a necessary and sensible activity. The end in view, or the use of the skill, removes drill from the dull routine of repetition and gives it meaning and sense."

—WILLIAM H. BURTON
Harvard University

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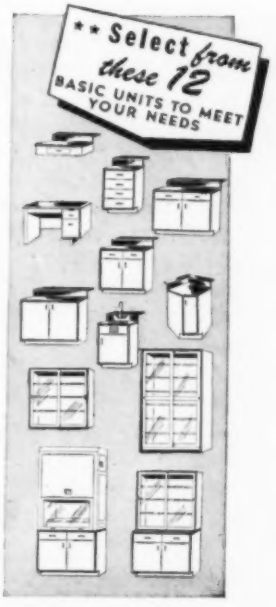

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Plants in Kodachrome

(Continued from Page 85)

ing in the diaphragm must be small enough to give good depth. It may become necessary to compromise between depth of the picture and length of exposure. In such cases I set the shutter speed at one-tenth, consult my exposure meter, and use the diaphragm opening most suitable for that speed. Slow shutter speeds necessitate the use of a tripod. A telescoping tripod with universal tilting top is stable enough for small cameras and should be used whenever possible. The composition of the picture is more easily controlled, fuzzy images resulting from movement of the camera are avoided, and the long waits which often occur before the plant stops moving are not so tiring.

Proper lighting is essential for accurate, brilliant color pictures. Kodachrome film works best in sunlight. Differentiation is accomplished more by the colors of the various parts than by highlights and shadows; consequently, uniformity of illumination is necessary for accurate color records. Sharp shadows should be avoided. To eliminate them some photographers shade the plants from the direct rays of the sun with a tent made of a single thickness of cheese cloth. I usually compose my picture and wait for a tiny cloud to shade the sun during the time of exposure. It does take time, but much more pleasing pictures result from the patient waiting. On cloudy days and whenever the subject is more than a thousand feet away, I use a haze filter in the lens hood to prevent excessive blueness.

Accuracy of exposure is essential for success in Kodachrome photography. Haphazard estimates of exposure time and diaphragm opening produce pictures ranging from thin, faded colors to dark reds and blues. Sheets issued with color film give exposure data for certain typical situations, but the conditions under which a nature photographer must work are so diverse that a light meter of the photoelectric type is a necessary part of the equipment. Its use enables one to determine accurately the exposure time for each picture. The sensitiveness of meters and the accuracy of the shutter mechanisms of cameras vary. Consequently, an exposure record should be kept until one is thoroughly familiar with the performance of both the camera and the meter in the various situations under which pictures are taken. I find that the lens opening and exposure time indicated by my meter when held in the camera position give fine results for pictures taken at distances from 16 inches to eight feet. For greater distances, meter readings are taken in the various parts of the field of the camera and the exposure established midway between the least and the greatest light intensity.

A collection of Kodachromes is not completed in a season. After you start taking pictures of plants you would not want it to be. As your collection grows there will be an increased interest in completing and improving your set, and a greater and greater joy in looking at and showing others your best pictures. At the same time you will have acquired an ideal means of relaxation and recreation. ●

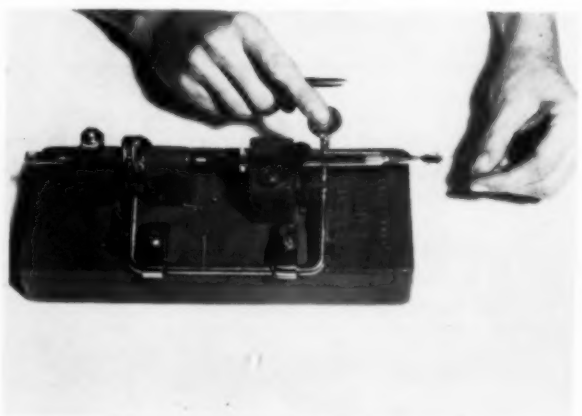
★ ★ ★ ★ ★

Oldest Agricultural Station

(Continued from Page 94)

"Science in a Democracy" by Dr. Detlev Bronk, President of Johns Hopkins University, and recently elected President of the National Academy of Science.

In the afternoon of September 29 a symposium on the place of research in modern society will be held. Dr. Edmund W. Sinnott, Director of the Yale University Scientific School will be the moderator of the symposium on "The Research Institute in Modern Society." Four nationally known speakers will speak on the several fields of research. Dr. G. O. Curme, Vice President, Carbide and Carbon Company will discuss "Industrial Research." Dr. S. A. Waksman, Head of the Microbiology Department of the New Jersey Agricultural Experiment Station, will speak on "Governmental Institutes," and Dr. Alexander Wetmore, Secretary of the Smithsonian Institution will tell about "Endowed Institutes." Dr. Sinnott will discuss "University Research."



THE MICRO-INJECTOR is a handy tool for insecticide studies. Here a live milkweed bug is being injected with a new insecticide formulation to determine its toxic powers.

It is well, too, that research has been done on agriculture. Think for a moment what might have happened if Johnson's idea of research "for the use of farming" had died in infancy. Those who now loudly propound the 150-year-old Malthusian principle would have *real* cause for alarm. They wouldn't have to excoriate agriculture. The *people* would be so foodshort they would be clamoring for action.

If research in agriculture had not been started by Prof. Johnson, there would surely have been less to eat for the people of today. China, with little research activity in agriculture and many people, is a living example.

Population growth provides a realistic approach. It is said that 800,000 Indians inhabited the 1,905 million acres of these United States when the first settlers set foot on our shores about 350 years ago. The first 200 years after the white man arrived, the population increased only to about 4 million people. By 1850 it had grown to 23 million, by 1900 it was 76 million, and in 1950 it is estimated that the population is about 150 million. For the year 2000 one population expert estimates that the population will be 186 million.

Had not scientists like Dr. D. F. Jones of this Station conducted tests and investigations for the improvement of agriculture, less food would be produced and available today. ●

★ ★ ★ ★ ★

Impregnation of Leather With Elastomers and Synthetic Resins

Resin treatments that promise to effectively improve the wear resistance of sole leather have recently been developed by Rene Oehler and Timothy J. Kilduff of the leather laboratory at the National Bureau of Standards[1]. In addition to increasing the abrasion resistance, the use of synthetic resins should reduce the amount of tanning materials now required to produce high-quality leather. The success of the resin treatments coupled with the knowledge gained in their development, suggested the possibility of a similar leather treatment using rubber. Further research is being directed toward this end by Bureau scientists.

During World War II the military and civilian requirements for shoes were so great that the tanning industry experienced difficulty in expanding operations sufficiently to meet the increased demand. Of chief concern were the acute shortages of hides and tannins (quebracho and other vegetable tannins). To alleviate the situation, the National Bureau of Standards investigated several oil and wax treatments, which were adopted by the Armed Forces to increase the wear resistance of sole leather. During these investigations it became evident that treatment with synthetic resins might further improve the wear of soles as well as make them and the upper leather more water resistant.

As a result of the war stimulus, three laboratory methods were developed for treating leather with resins. The first method of treatment may be accomplished by immersing the leather specimens in manomer and subsequently polymerizing *in situ;* the second method consists in immersing leather in polymer solutions, which may or may not be elastomers; while the third involves immersion in a partially polymerized liquid resin which is further polymerized in the leather itself. In connection with the second method, gutta-percha, Castilloa and Hevea natural rubbers, as well as synthetic elastomers, and various acrylate solution-poly-

[1] For complete technical details of the work on resins, see "Treatment of leather with synthetic resins," by Rene Oehler and Timothy J. Kilduff, J. Research NBS **42**, 63 (1949) RP1951.

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mers were tried. The third method of impregnation was developed in cooperation with the Thiokol Corporation, using Thiokol LP-2.

Abrasion resistance as determined with the National Bureau of Standards abrasion machine—an indication of the wear to be expected of sole leather—is improved approximately 75 per cent for vegetable-tanned crust leather impregnated with *n*-butyl methacrylate monomer, followed by polymerization *in situ*. The abrasive resistance of the untreated crust leather was approximately the same as that of sole leather. Treatment of vegetable-tanned crust leather with solutions of Castilloa rubber improves abrasion resistance about 50 per cent, while treatment with Thiokol LP-2 improves resistance about 30 per cent. However, treatment of vegetable-tanned crust leather with polybutyl methacrylate solution-polymer showed no improvement in abrasion resistance.

Results of half-hour static water absorption tests reveal a reduction of one-tenth to one-third the amount of water absorbed by untreated leather, depending upon the kind of leather and treatment. Water vapor permeability of treated shoe upper leather is higher than similar leather containing 20 percent grease.

Preliminary research with rubber solutions has shown that, by proper choice of processing methods, as much as 20 per cent of rubber can be deposited within unfinished vegetable-tanned leather. The process may be satisfactorily applied to several different types of leather. Dynamic, or wet-flex, water absorption and water transmission of sole leather as well as abrasion resistance are all improved about 50 per cent by rubber treatments. Solutions of natural rubbers having 40 per cent or more of rubber are prepared from cold milled rubbers and conventional solvents. The impregnated rubber may be vulcanized in place by the use of an ultra accelerator of the dithiocarbamate type. Service tests on shoe soles and pilot plant processing runs are planned as the next step in the investigation. ●

★ ★ ★ ★ ★

"It is true that hundreds of plants could be grown in a schoolroom without any appreciable educational results occurring. Everything depends on how the teacher takes advantage of the opportunities as they arise, his ability to manipulate the environment, his sensitivity to the importance of reflective thought, and his skill in providing for it."

—G. MAX WINGO
University of Michigan

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(Continued from Page 99)

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